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PRELIMINARY SYSTEMS ANALYSIS AMPHIBIOUS CARGO BEACHING LIGHTER

by

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The Naval Facilities Engineering Service Center is developing an advanced modular causeway system known as the Amphibious Cargo Beaching Lighter (ACBL) to increase cargo throughput, improve hydrodynamic stability, and containerize systems for shipboard delivery. This high sea state lighterage opens a window of opportunity to the emerging requirement of conducting operations in wave conditions through sea state 3. The preliminary systems analysis described in this report represents a first cut at identifying some of the cost and logistical implications arising from 6.2-sponsored engineering research and development efforts associated with the new ACBL and its innovative rigid and flexible connector systems. The preliminary systems analysis task addresses some of the “cradle-to-grave” implications of wholesale pontoon-based asset replacement by the proposed ACBL. This report presents the baseline results of a life cycle cost study of competing concepts, and considers potential impacts of change to the supporting foundation of NL assets held by the Navy and counterpart watercraft assets held by the Army.

14. SUBJECT TERMS

Amphibious Cargo Beaching Lighter (ACBL), Navy Lighter (NL), Joint Logistics Over the Shore (JLOTS), barges, causeways, life cycle cost analysis (LCCA), life cycle cost model (LCCM)

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EXECUTIVE SUMMARY

It is projected that up to 90% or more of combat equipment and military materiel will be delivered to a conflict by sealift. In areas where port facilities are inadequate or not secured, the unloading of sealift ships is accomplished by a throughput operation known as Logistics Over the Shore (LOTS). A critical element of LOTS delivery is lighterage, powered, and non-powered causeway components that may be assembled into barge ferries, floating piers, and other supporting platforms. The dominance of containerized cargo delivery witnessed in today's shipping technology, coupled with changing patterns of threat in global politics, as well as the fleet's identified requirement to stage LOTS operations in sea conditions through sea state 3, have combined to expose a fundamental need for change in the design, assembly, and operation of military ship-to-shore amphibious supply craft.

The Naval Facilities Engineering Service Center (NFESC) is developing an advanced modular causeway system known as the Amphibious Cargo Beaching Lighter (ACBL) that will substantially increase cargo throughput, improve hydrodynamic stability in rough seas, and afford containerization of system components for shipboard delivery. Individual components of the ACBL system are modular in construction, and may either be deck-loaded aboard a vessel or stored in adjacent cargo cells within the hold of a container vessel. A triad of modules, each sized nominally at 24 feet in width, 40 feet in length, and 8 feet in depth, provide the fundamental building blocks necessary to assemble a 120-foot long barge on the water. Wider platforms, when required, are assembled by joining two or more barges together side-by-side. A group of barges assembled on the water may be linked to create other extended platforms.

NFESC has identified two concepts of modularization for possible development as the ACBL. In the **"**monocoque**"** vision, each 40- by 24- by 8-foot module is fabricated as a monolithic steel structure, fully assembled prior to loading aboard a waiting container ship. In the **"**intermodal**"** vision, each steel module is assembled dockside, prior to loading aboard a containership, from three ISO-configured sub-modules, each sized 40 by 8 by 8 feet. Thus, the intermodal alternative offers the flexibility of truck or train delivery from inland fabricators to the harbor, while construction and movement of monocoque hardware is essentially limited to coastal locations.

In order to identify and quantify some of the "cradle-to-grave" cost and logistical implications arising from the ACBL and its fabrication options, a preliminary systems analysis was conducted. As part of that analysis, site surveys were conducted at key Navy, Marine Corps, and Army amphibious support locations in order to document changes within the infrastructure required to accommodate the proposed ACBL replacement technology. In addition, NFESC contracted Cost Engineering Research Incorporated (CERi) during FY96 to construct a Life Cycle Cost Model (LCCM) for estimating the total lifetime costs associated with the steel monocoque and intermodal options of the ACBL under conditions of joint procurement by Army and Navy. The life cycle process recognizes that the purchase price of a developmental piece of military hardware represents only a part of the total cost of ownership. The LCCM that was developed amplifies total costs and compares the current monetary advantages and disadvantages of executing either alternative, given the "best shot" quality of input data available at the time. Although the life cycle cost model is fully integrated in terms of analytical structure, further refining of output information can be achieved with improvements in the quality of input data as the program matures. Thus, the model produces a living document that can be updated in the future as input parameters change or as systems information becomes more refined.

The LCCM uses linked Microsoft EXCEL spreadsheets to process input data, execute the required calculations, and present the output information. Costs are calculated for Phase II, Engineering and Manufacturing Development, and for Phase III, Production, Deployment and Operational Support. Results are presented in constant FY97 dollars as well as in Then-Year dollars corrected by applying current DOD escalation rates. A comparison of bottom lines for the competing concepts indicates that in terms of Then-Year dollar expenditures, the life cycle cost of the monocoque alternative is $780 million less than the cost of the intermodal design over the 20-year span of the Life Cycle Cost Model. Overhaul cost stemming from periodic contractor and governmental servicing programs is the number one cost driver for both the monocoque and the intermodal concepts.

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INTRODUCTION

The revolution in shipping technology during the last two decades, coupled with changing patterns of threat in global politics, have exposed a fundamental need for change in the design, assembly, and operation of military ship-to-shore amphibious supply craft. In areas where port facilities are inadequate or unsecured, shallow-draft barges called lighters are used to shuttle military equipment through the surf zone in a cargo throughput operation known as Logistics-Over-The-Shore (LOTS). For the past 50 years, Navy-Lightered (NL) pontoon assets have been carried aboard dedicated transport vessels such as the Landing Ship Tank (LST). However, specialized Navy ships are being retired from service without replacement as commercial container vessels conforming to International Organization for Standardization (ISO) guidelines gain increasing favor within the military as a universal standard of transport. At the same time, current visions of engagements “from the sea” identify a strategic need for accelerated cargo throughput, and a sustained delivery capability over greater distances and under a wider spectrum of sea states. Implied in these evolving requirements is the need for increased hydrodynamic stability and greater load capacity over a broad range of wave periods and amplitudes.

In 1993, the Director of Logistics Plans and Policy for the Navy’s Strategic Sealift programs (N42) acknowledged existing deficiencies, and requested research and development of an advanced lighter to replace the aging NL system of causeways. At about the same time, and in response to the DoD Mobility Requirements Study published by Congress, the Army War Reserve (AWR) program initiated a dramatic overhaul of the Army Preposition Afloat (APA) system, greatly accelerating the rate of vessel deployment. Army concerns for modular construction, expedient assembly of watercraft on the open seas, and high sea state performance are similar to objectives of the Navy and Marine Corps program. The joint services stand to benefit from research and development conducted at the Naval Facilities Engineering Service Center (NFESC).

NFESC is developing an advanced modular causeway system known as the Amphibious Cargo Beaching Lighter (ACBL) to increase cargo throughput, improve hydrodynamic stability, and containerize systems for shipboard delivery. Individual components of the ACBL system are modular in construction, and may either be deck-loaded aboard a vessel or stored within adjacent container cells in a ship’s hold for transport to an Amphibious Objective Area (AOA). An innovative connector technology developed under the umbrella of the ACBL program enables a triad of modules offloaded onto the water to be joined rigidly end-to-end to form a continuous-deck lighter, or causeway section. Multiple causeway sections so assembled may be rigidly connected side-to-side to form a double-wide or even triple-wide barge structure. Alternately, multiple lighters may be linked end-to-end using flexible connectors to assemble a string of lighters used as a barge ferry or floating causeway. Specialized structures such as the Roll-on/Roll-off Discharge Facility (RRDF) and the Air Cushion Vehicle Landing Platform (ACVLAP) are assembled on the water using combinations of rigid and flexible connector. Increased length and depth of the ACBL provides greater payload capacity while significantly increasing hydrodynamic stability on active seas. In fact, the high sea state lighterage proposed by the ACBL program opens a window of opportunity to the emerging requirement of conducting LOTS operations and combined-service JLOTS (Joint-Logistics-Over-The-Shore) operations in wave conditions through sea state 3. Potential cargo throughput is increased both by increasing the tonnage carried per lighter and by increasing the number of operational days available during a “statistical” month.

Although the current NL system of the Navy and Modular Causeway System (MCS) of the Army fail to meet the far term prepositioning requirements of the DoD, they do represent a sizable investment in terms of pontoon asset inventory, sealift support, shore-side maintenance facilities, training structures and staffing personnel. While it is reasonable to venture that the ultimate configuration and operation of a wholesale replacement system will dictate the level of logistical support required, it is equally reasonable to expect that the existing investment in maintenance facilities, transportation structures, staffing allocations and training programs can and should have a bearing on the overall engineering decision making process. During 1996, site surveys were completed at key Navy, Marine Corps, and Army amphibious support locations in order to document changes within the infrastructure that will be required to accommodate the ACB lighter system.

The preliminary systems analysis described in this report represents a first cut at identifying some of the cost and logistical implications arising from 6.2-sponsored engineering research and development efforts associated with the new ACBL and its innovative rigid and flexible connector systems. The preliminary systems analysis task addresses some of the "cradle-to-grave" implications of wholesale pontoon-based asset replacement by the proposed ACBL. This report presents the baseline results of a life cycle cost study of competing concepts, and considers potential impacts of change to the supporting foundation of NL assets held by the Navy and counterpart watercraft assets held by the Army.

BACKGROUND

The basic building block used in the assembly of conventional Navy pontoon structures is the NL pontoon, a rectangular, watertight, internally-reinforced steel box that is 5 feet wide by 7 feet long by 5 feet high. Some of the most commonly used pontoon structures, including lighters and individual sections of floating causeway pier, are configured around a basic "three string" module that is 3 pontoons wide by 15 pontoons long, giving nominal deck dimensions of 21 by 90 feet. The Army MCS is a modular system that consists of a center module 40 feet long and two end modules each 20 feet long; the pontoon sections joined rigidly to produce a lighter that is 80 feet long, 24 feet wide and 4.5 feet deep. Such pontoon-based floating structures as the Navy NL lighter and Army MCS, shown in Figures 1 and 2, respectively, are particularly vulnerable to the chaos of the seas because the defining "shoe box" shape offers a large waterplane surface that responds aggressively to excitations in the ambient hydrodynamic environment. As a result, prevailing conditions of wave and swell induce random rigid-body motions that remain largely undamped without external control. As motion and trim increase in heavy seas, so does the likelihood of damage and injury onboard as green water washes over the deck. The comparatively shallow 5-foot depth and short 90-foot length restrict safe operations onboard to sea state 2 and below conditions. Another logistical drawback of the existing technology is that each large NL causeway must be bolted together in full assembly prior to loading and transport aboard a dedicated ship. Since current downsizing of the fleet includes deactivating required LST-type vessels in favor of standard commercial containerships, the replacing ACB lighter technology encompasses concepts for ISO-compatible, "container-sized" modules that can be assembled into barges and larger platform structures on the open seas.

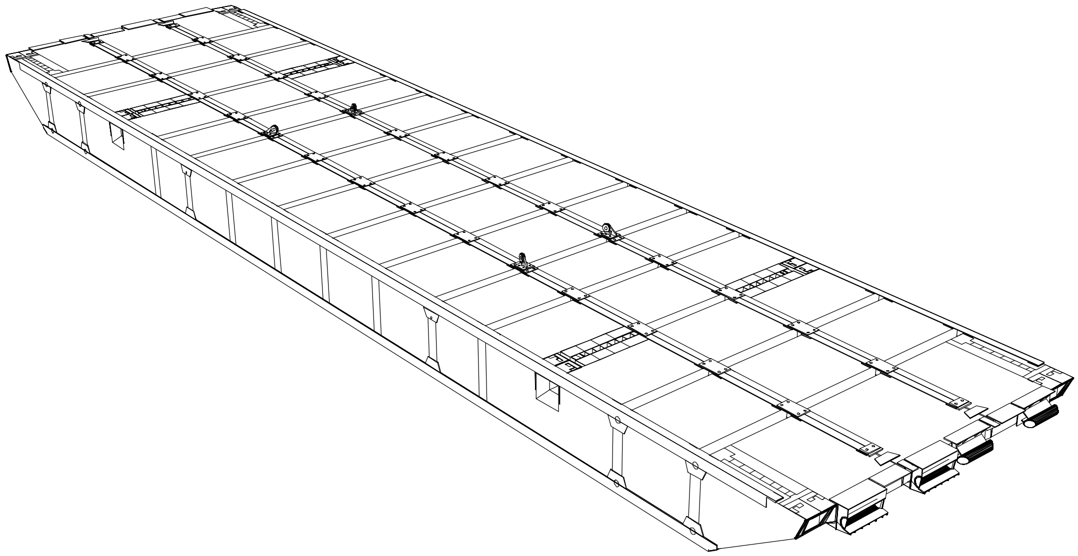


Figure 1. The Navy-Lightered Causeway Section.

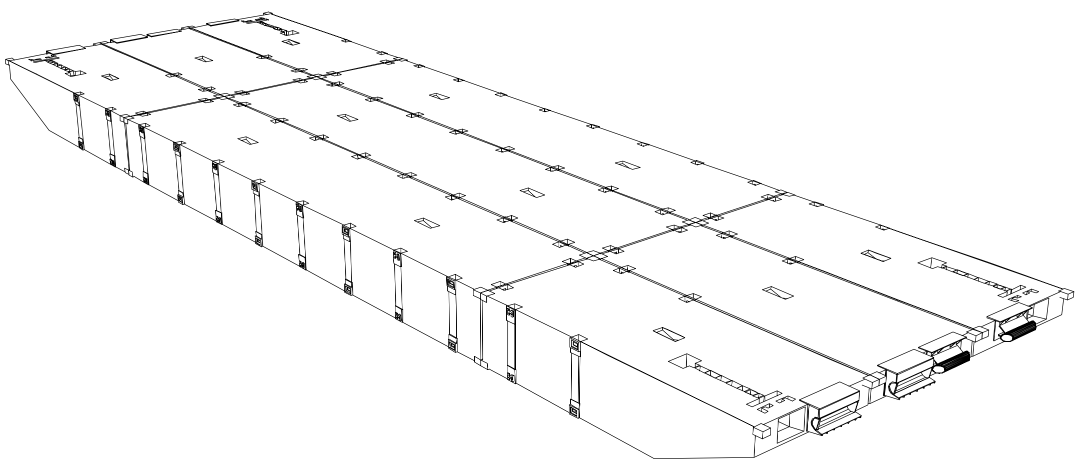
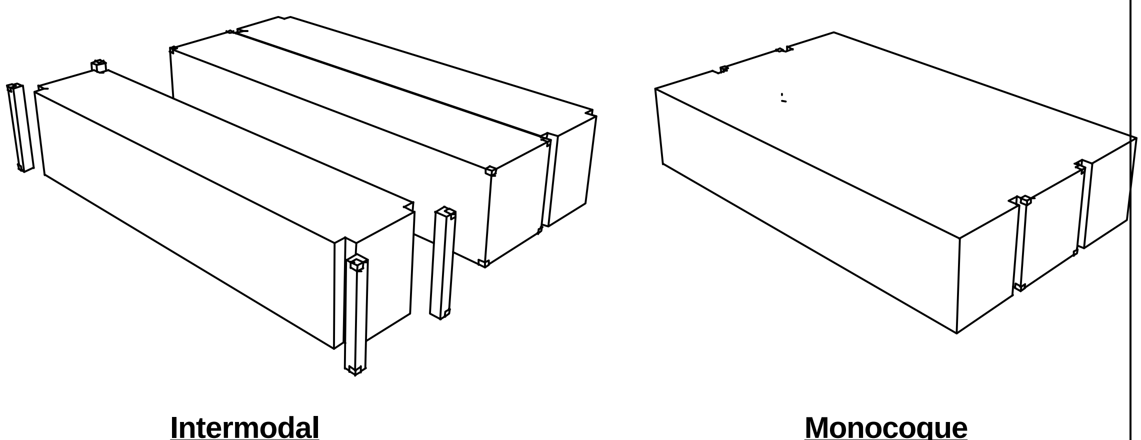


Figure 2. The Army Modular Causeway System lighter.

The NFESC is advancing the ACBL concept as the basis for the next generation of ship-to-shore military amphibious barge. A triad of ISO-compatible modules, each sized nominally at 24 feet in width, 40 feet in length, and 8 feet in depth, provides the fundamental building blocks necessary to assemble a basic 120-foot long platform barge, or a family of larger structures, on the water. The continuous deck surface produced by rigidly joining three pontoon modules in fixed end-to-end articulation provides improved hydrodynamic stability and greater flexibility in cargo layout. Wider platforms, when required, are assembled by joining one or more barges together rigidly using the same type of connector in a side-to-side application. A group of assembled barges may be linked on the water using flexible-type connectors to form a variety of useful platforms.

NFESC has identified two concepts of modularization for possible development as the ACB lighter. In the **“**monocoque**”** vision, each 40- by 24- by 8-foot module is fabricated as a monolithic steel structure, fully assembled prior to loading aboard a waiting container ship. In the **“**intermodal**”** vision, each steel module is assembled dockside, prior to loading aboard a containership, from three ISO-configured sub-modules, each sized 40 by 8 by 8 feet. Thus, the intermodal alternative offers the flexibility of truck or train delivery from inland fabricators to the harbor, while construction and movement of monocoque hardware is essentially limited to coastal locations. The two concepts are pictured side by side in Figure 3.

Figure 3. Intermodal “trimodule” and Monocoque “monolith”.



The monocoque concept was explored in contractor reports issued by M. Rosenblatt & Son, Inc., in December 1995 (Ref 1) and June 1997 (Ref 2). The preliminary structural design of a monolithic steel module was investigated in order to establish the feasibility of producing a light but durable hull structure limited to approximately 67,200 pounds. The intermodal concept, or Tri-Module configuration as also referred to, was explored in a December 1995 contract report issued by M.J. Plackett & Associates (Ref 3). Plating and frame sizes were recommended for the smaller 40- by 8- by 8-foot intermodal submodules. Specifications contained in these two reports were used as the basis for securing fabrication cost estimates from a local maritime contractor. The estimates were accepted as production inputs into a life cycle cost model (LCCM).

LIFE CYCLE COST

The purchase price of a developmental piece of military hardware represents only a part - sometimes a small part - of the total cost of ownership. The life cycle cost (LCC) of an item is the total cost of that item at the end of its lifetime. LCC techniques consider all future expenses for research and development, production, modification, transportation, new facilities, operation, support, maintenance, disposal, and all other costs of ownership, less any revenue claimed by salvage. LCC specifically excludes any money that has already been obligated or spent at the time the study is initiated because "sunk" funds should not bear on future decisions.

A primary motivator behind LCC is saving money on chronic operational and support costs by increasing one-time investments in research and development during procurement. LCC methods seek to identify and amplify the significant cost drivers - that is, product characteristics that result in disproportionately large costs. Once such factors are illuminated, they can be targeted for reduction by key planning and design decisions. LCC techniques are particularly beneficial when two or more "competing" concepts can be compared one-on-one using equivalent tools and evaluation criteria.

NFESC contracted Cost Engineering Research Incorporated (CERi) during FY96 to construct a LCCM for estimating the total lifetime costs associated with the steel monocoque and intermodal options of the ACBL (Contract N47408-96-M-8399) under conditions of joint procurement by Army and Navy. The LCCM that was developed amplifies total costs and compares the current monetary advantages and disadvantages of executing either alternative, given the "best shot" quality of input data available at the time. Although the life cycle cost model is fully integrated in terms of analytical structure, further refining of output information can be achieved with improvements in the quality of input data as the program matures. Thus the model produces a living document that can be updated in the future as input parameters change or as systems information becomes more refined. A major part of the contractor's effort, for instance, was expended in obtaining relevant maintenance and operational cost data from the Navy and Army for their NL and watercraft systems, respectively. Due to the relatively compressed schedule of execution, however, which happened to also coincide in time with the end-of-the-year holiday season, not all of the information solicited from cognizant Army and Navy groups was collected and verified. Even taking into consideration the lack of complete and accurate support data, the contractor still supports a +/- 10% confidence in the Navy portion of accumulated costs. The larger number of assumptions required to execute the Army calculations degraded that part of the study to +/- 15% confidence.

Methodologies

Three principal methodologies of estimating are recognized by practitioners of LCC. Each application has its own particular merits and shortcomings. In general, the techniques of analogy, parametric study, and cost engineering provide increasing accuracy and depth of analysis. Estimates by analogy use information and numbers from similar past or parallel programs to generalize input conditions to the study at hand. Costs of a prior system are compared to those of a similar new system. When a wider range of data is available from a number of programs, empirical numerical correlation between corresponding input characteristics may be expressed as parametric relationships, sometimes called Cost Estimating Relations (CER). Thus the parametric method extends the characteristics of a known system to those of a new system. Whereas estimates by analogy and parametric study involve “top down” methods because they examine the program as a whole, the older method of cost engineering is a “bottom up” technique that develops detailed costs for each element comprising the whole program. Cost engineering uses a Work Breakdown Statement (WBS) of the new system to identify end products and services, using known estimates of labor and material costs to calculate the various expense elements. No one method is superior to the others. The optimum approach depends upon a number of factors, including the quality and quantity of input data, the time available to conduct the study, and the degree of working level detail required by the program manager. A fourth estimating technique, the hybrid approach, picks and chooses applicable parts from the other methods for a custom presentation. The hybrid approach allows greater flexibility and is preferred whenever input data for the replacing system does not correspond directly with parameters used to define the obsolescing system.

Given the need to discriminate between Level III cost elements contained in MIL-GUIDANCE-881B, coupled with the evolving nature of the ACBL input data, a responsive, flexible representation was developed as the most appropriate model. Thus the cost estimating tools developed to model the life of the ACBL are based on hybrid methodology. The WBS is presented in Figure 4. The LCCM employs one or more of the classical methods at each of the WBS levels and for each life cycle phase as a means of obtaining a realistic estimate, given the uncertainty of available input data.

Levels

I II III IV

ACBL

- Prime Mission Product (PMP)
  - Monocoque Lighter
    - (includes the lighter, connecting hardware, fittings, system integration and assembly)
  - Intermodal Lighter
    - (includes the sub-modules, hardware, fittings, system integration and assembly)
  - Ancillary Hardware
    - (includes power units, winches, hydraulics, A-Frames, and related hardware)
- System Engineering/Program Management
- Packaging, Handling, Storage, and Transportation
- System Test and Evaluation
- Initial Spares and Repair Parts
- Unit Mission Personnel
- Unit Level Consumption
  - Repair Parts/Supplies
  - Fuel
- Intermediate Maintenance
- Depot Maintenance
  - Overhauls
  - Nonscheduled Maintenance
  - Equipment Rework
- Contractor Support Services
- Sustaining Support
  - Support Equipment Replacement
  - Centrally Provided Material
  - Sustaining Engineering Support
  - Other
- Indirect Support
- System and Inventory Management Control
- Disposal

Figure 4. ACBL work breakdown statement.

Structure

The ACBL life cycle cost model uses linked Microsoft EXCEL spreadsheets to process input data, execute the required calculations, and present the output information. The high level architecture is shown in Figure 5. Data is input into a single spreadsheet called CARD, which is an acronym for Cost Analysis Requirements Description. The list of values input into the data cells of the CARD spreadsheet is very extensive, and the source of each data entry is qualified as being either a government-provided engineering judgment, contractor-furnished information, CERi assumption, algorithm assumption, historical data, programmatic data, or link to another spreadsheet. The table of contents defining the hierarchy of CARD functions is presented in Figure 6.

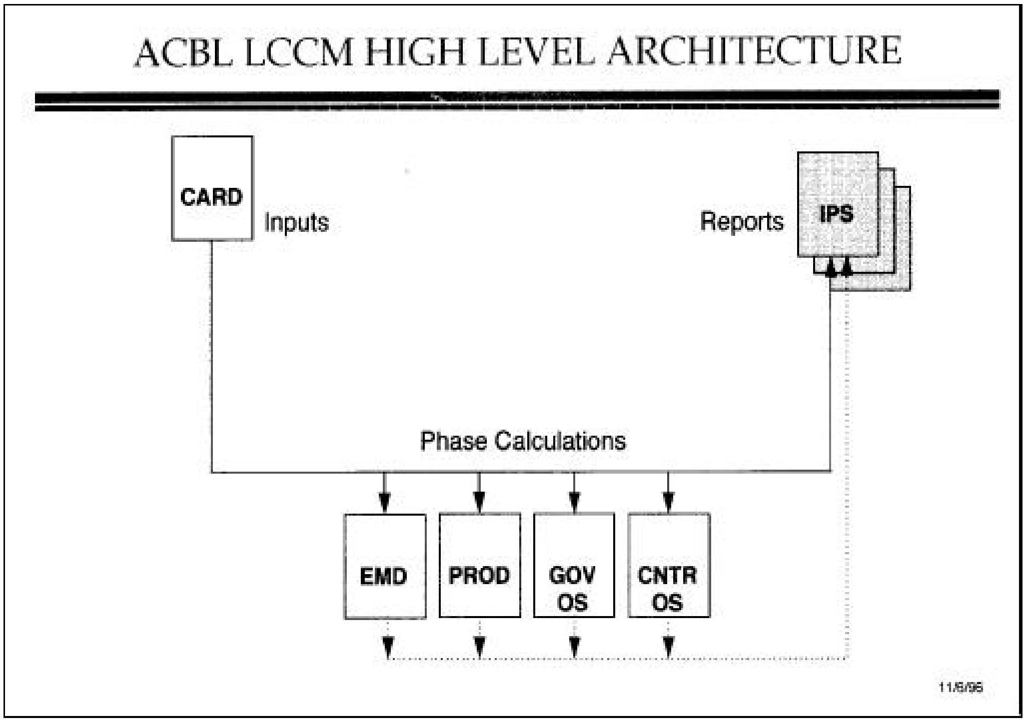


Figure 5. High level architecture of life cycle cost model.

Section	Category
1	Cell Legends
2	Acquisition Phase Days
3	RDT&E Expenditures
4	Prototype Schedule
5	E&MD Milestones and Schedule
6	LRIP / FRP Milestones and Schedule
7	Quantity of ACB Lighter Modules
8	ACB Lighter Cost Factors
9	CS(M) Additional Cost Factors
10	Physical Description and Calculated Costs of CS(M) Sub-systems
11	CS(M) Operational Deployment
12	Annual Missions / Deployments
13	ACB Lighter Service Life and Fail Repair Data
14	ACB Lighter Annual Repair Actions, Times, and Costs
15	ACB Lighter Annual Training Requirements and Costs
16	ACB Lighter CSE and PSE Annual Replenishment Requirements
17	ACB Lighter Disposal Costs
18	ACB Lighter Salvage Value
19	ACB Lighter Overhaul Costs
20	Deliveries and Fleet Populations
21	Escalation
22	Constants

Figure 6 . Contents of CARD input.

Figure 5 shows four computational spreadsheets in which costs are calculated for the two specific life cycle phases addressed in this model: Phase II, Engineering and Manufacturing Development (E&MD), and Phase III, Production, Deployment and Operational Support (PD&OS). Although a single spreadsheet (E&MD) serves to process Phase II calculations, Phase III is subdivided into three separate spreadsheets in order to add clarity and definition to the matrix of activities and costs that are possible. There is a single spreadsheet (PROD) for the production sub-phase, and two spreadsheets for the operational support sub-phase, one focused on government costs (GOV-OS) and the second on contractor costs (CON-OS). In the calculation mode, WBS elements are partitioned according to three principal categories of cost: (1) primary hardware (i.e. ACB monocoque or intermodal modules); (2) additional materials (i.e. diesel engines, winches, A-frames, fender systems, lighting, and anchors); and, (3) government management, support, and services. Costs are calculated for each of the categories, and then summed up by fiscal year and cycle phase to produce select life cycle cost reports as output.

Data Collection and Assumptions

Data collection consisted of telephone calls and site visits to representatives of government and industry. Not all responses were timely enough to be considered in the LCCM. A number of assumptions were made based on input from government and contractor experience. The nature of the effort put forth to collect data and the assumptions made to drive part of the model are considered in Appendix A.

Results

The summary of life cycle cost estimates is presented in Table 1. Results are presented in constant FY97 dollars and in Then-year dollars (corrected using currently published DoD escalation rates). A comparison of bottom-lines for the competing concepts indicates that in terms of then-year dollar expenditures the life cycle cost of the monocoque alternative is $780 million dollars less than the cost of the intermodal design over the 20 year span (1996 - 2015) covered by the Life Cycle Cost Model.

Table 1. Summary of Life Cycle Cost Estimates

	MONOCOQUE	INTERMODAL
	(FY 97 $M)	(FY 97 $M)
DEVELOPMENT	$53.97	$58.42
Lead Project	$3.65	$3.65
Contractor	$19.83	$24.28
Government	$30.49	$30.49
PRODUCTION	$482.74	$570.68
Contractor	$461.98	$549.93
Government	$20.75	$20.75
O&S	$1,424.72	$1,946.57
Contractor	$241.33	$334.64
Government	$1,183.39	$1,611.93
TOTAL (FY 97 $M)	**$1,961.43**	**$2,575.68**
(Then Yr $M)	(Then Yr $M)	
DEVELOPMENT	$59.26	$64.27
LEAD Project	$3.64	$3.64
Contractor	$22.70	$27.72
Government	$32.92	$32.92
PRODUCTION	$573.24	$677.81
Contractor	$549.22	$653.79
Government	$24.02	$24.02
O&S	$1,832.61	$2,502.95
Contractor	$314.45	$436.05
Government	$1,518.16	$2,066.90
TOTAL (Then Yr $M)	**$2,465.1 1**	**$3,245.047**

Engineering and Manufacturing Development. Table 2 is a more detailed summary of the Phase II Engineering Manufacturing and Development phase with separate breakdowns shown for Navy and Army production. The LEAD Project refers to the Logistics Engineering Advanced Demonstration test, an advanced technology demonstration conducted for program definition and risk reduction. The contractor was provided with estimated cost data for the LEAD project as shown in Table 3.

Table 2. ACBL Development Summary

MONOCOQUE		INTERMODAL	
	(FY 97 $M)		(FY 97 $M)
Lead Project	$3.65	Lead Project	$3.65
E&MD-Navy	$17.35	E&MD-Navy	$21.29
E&MD-Army	$2.48	E&MD-Army	$2.99
Government	$30.49	Government	$30.49
TOTAL	**$53.97**	**TOTAL**	**$58.42**
	(Then-Year $M)		(Then-Year $M)
Lead Project	$3.64	Lead Project	$3.64
E&MD-Navy	$19.85	E&MD-Navy	$24.28
E&MD-Army	$2.86	E&MD-Army	$3.44
Government	$32.92	Government	$32.92
TOTAL	**$59.26**	**TOTAL**	**$64.27**

Table 3. Risk Reduction Advanced Technology Demonstration

	Execution Plan											
	FY-96				FY-97				FY-98			
LEAD Project	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Requirements	$230 k											
Contract Award		$218 k										
Design				$844 k								
Fabrication							$1532 k					
Test and Eval.									$704 k			
Transition											$110 k	

The line items E&MD-Navy and E&MD-Army in Table 2 refer to the fabrication costs associated with the pre-production prototypes. Table 4 is the production schedule for the entire buy broken down by number of platforms per particular full rate production (FRP) purchase. CS(M) refers to a generic platform type (e.g. barge ferry, warping tug, RRDF, etc.), where the top numerical row in the table defines the number of monocoque modules comprising that particular platform. For example, looking directly beneath the top numerical row, it is seen that during E&MD delivery, the Navy buys one RRDF platform that is made up of 18 monocoque modules. The bottom three rows summarize the total buy in terms of quantity of platforms, quantity of monocoque modules, and quantity of intermodal modules, respectively. The total Navy buy is assumed to consist of 141 platforms, requiring 1,173 monocoque modules, or 3,519 intermodal modules. The Army buy consists of 66 platforms, consisting of 519 monocoque modules or 1,557 intermodal modules. Table 4 was generated using information from Tables 5 and 6 which were provided to the contractor as part of the government furnished information (GFI).

The Army schedule of annual deliveries of CS(M) was not known at the time of this study - only the total numbers of platforms was published. In the numerical analysis, the LCCM scheduled the Army buy so that the total annual delivery of CS(M) to Army and Navy together was approximately 40 platforms. The delivery rate at full production was assumed to be 120 modules per month with deliveries starting one month after contract award. Production costs were developed from fabrication estimates provided by a local maritime contractor, presented in Appendix B. Using those estimates as a guideline, the average costs of intermodal and monocoque lighters input to the model are $818,308 and $648,796, respectively.

The line item Government includes the cost of providing in-house technical and logistical support, and contract monitoring. Table 7 is a breakout of estimated government support costs for engineering support that were provided to the contractor. Also included in the Government line item are costs associated with required military construction (MILCON) and the purchase of spares. Table 8 was provided to the contractor as a preliminary guide to government capital outlay costs.

Table 4. Breakdown of Module Delivery to Navy and Army

	Navy Lighterage (NL) CS (M) Sub-Systems								Navy Total	Army Modular Causeway (MC) CS (M) Sub-Systems								Army Total	Total
	CSNP	CSP	Warp Tug	Brg Ferry	Float CS	RRDF	ACVLAP	Transitn		CSNP	CSP	Warp Tug	Brg Ferry	Float CS	RRDF	ACVLAP	Transitn		
Modules/Subsys	3	3	3	9	13	18	36	1		3	3	3	9	13	18	36	1		
CS(M) Qty	0	0	2	1	0	1	1	0	5	0	0	0	1	0	0	0	0	1	6
EMD Modules	0	0	6	9	0	18	36	0	69	0	0	0	9	0	0	0	0	9	78
CS(M) Qty									0									0	0
LRIP Modules	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS(M) Qty			10	17		1	1		29			6	4	1				11	40
FRP1 Modules	0	0	30	153	0	18	36	0	237	0	0	18	36	13	0	0	0	67	304
CS(M) Qty			10	16		1	1		28			6	4	2	2			14	42
FRP2 Modules	0	0	30	144	0	18	36	0	228	0	0	18	36	26	36	0	0	116	344
CS(M) Qty			10	17		1	1		29			6	4	1	2			13	42
FRP3 Modules	0	0	30	153	0	18	36	0	237	0	0	18	36	13	36	0	0	103	340
CS(M) Qty			10	16		1	1		28			6	4	1	2			13	41
FRP4 Modules	0	0	30	144	0	18	36	0	228	0	0	18	36	13	36	0	0	103	331
CS(M) Qty			10	10		1	1	0	22			6	4	1	3			14	36
FRP5 Modules	0	0	30	90	0	18	36	0	174	0	0	18	36	13	54	0	0	121	295
CS(M) Qty								0	0			0			0			0	0
FRP6 Modules	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS(M) Qty									0			0			0			0	0
FRP7 Modules	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS(M) Qty									0									0	0
FRP8 Modules	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS(M) Qty									0									0	0
FRP9 Modules	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total CS(M)	0	0	52	77	0	6	6	0	141	0	0	30	21	6	9	0	0	66	207
Total Modules	0	0	156	693	0	108	216	0	1173	0	0	90	189	78	162	0	0	519	1692
Tot Submodules	0	0	468	2079	0	324	648	0	3519	0	0	270	567	234	486	0	0	1557	5076

Table 5. GFI Estimates of Navy and Army Delivery

Platform Type	Navy CS(M)	Navy lighter	Army CS(M)	Army lighter
Floating Causeway Pier 24'x 840'				
Floating Causeway Pier 24'x 1560'			6	78
RRDF 72' x 240'	6	36	9	54
ACVLAP 96' x 360'	6	72		
Barge Ferry 24' x 360'	77	231	21	63
Warping Tug 24' x 120'	52	52	30	30

Note: a lighter is comprised of 3 monocoque or 9 intermodal modules.

Table 6. GFI of Navy Delivery Schedule

DEPLOYMENT TYPE	FY01	FY02	FY03	FY04	FY05	FY06	FY07
PHIBCBs							
RRDF	1				1	1	
ACVLAP	1	1		1	1	1	
Causeway ferry	1				8		
Warping Tug	2	4	2	4	4		
MPF Ships							
RRDF		1	1	1			
ACVLAP			1				
Causeway ferry		17	16	17	8	10	
Warping Tug		6	8	6	6	10	

Table 7. GFI Government Support Costs

Year	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
Salaries	588	1324	1625	1816	2403	2476	2598	2612
Direct Support	102	236	291	336	448	473	507	519
Indirect Support	50	110	135	151	199	206	216	217
Contracted Support	2122	2122	2185	2251	2319	2388	2460	2533
Total support cost $K	**1770**	**3792**	**4236**	**4554**	**5369**	**5542**	**5781**	**5881**

Table 8. GFI Capital Outlay Costs

Year	FY01	FY02	FY03	FY04
Spares $K		4122	4245	4372
Milcon $K	1739	1791	1845	1900

Production. Table 9 is a more detailed summary of the Phase III production phase with separate breakdowns shown for Navy and Army production. The line items Production-Navy and Production-Army refer to the fabrication costs associated with the delivery of production modules. Table 10 is the schedule of the production part of the total buy (extracted from Table 4) broken down by number of platforms per FRP delivery to Army and Navy. The line item Government includes the remaining costs of technical support, military construction, and spares using information provided in Tables 7 and 8.

Table 9. ACBL Production Summary

MONOCOQUE		**INTERMODAL**	
	(FY 97 $M)		(FY 97 $M)
Production-Navy	$314.1	Production-Navy	$374.2
Production-Army	$147.9	Production-Army	$175.7
Government	$20.75	Government	$20.75
TOTAL	**$482.7**	**TOTAL**	**$570.7**
(Then-Year $M)		(Then-Year $M)	
Production-Navy	$372.7	Production-Navy	$444.1
Production-Army	$176.5	Production-Army	$209.7
Government	$24.02	Government	$24.02
TOTAL	**$573.2**	**TOTAL**	**$677.8**

Table 10. Production Portion of Total Buy.

	NAVY CS(M)					ARMY CS(M)				
	Warp Tug	Brg Ferry	Float CS	RRDF	ACVLAP	Warp Tug	Brg Ferry	Float CS	RRDF	ACVLAP
LRIP	0	0	0	0	0	0	0	0	0	0
FRP1	10	17	0	1	1	6	4	1	0	0
FRP2	10	16	0	1	1	6	4	2	2	0
FRP3	10	17	0	1	1	6	4	1	2	0
FRP4	10	16	0	1	1	6	4	1	2	0
FRP5	10	10	0	1	1	6	4	1	3	0
FRP6	0	0	0	0	0	0	0	0	0	0
FRP7	0	0	0	0	0	0	0	0	0	0
FRP8	0	0	0	0	0	0	0	0	0	0
FRP9	0	0	0	0	0	0	0	0	0	0

Operational Support. Typically, operating and supporting military hardware represents the largest part of total life cycle cost. Operating costs occur whenever an item is used, resulting in charges to personnel and consumable goods. Support costs result from the continuing need for maintenance, provisioning, and training over the lifetime of the system.

Operational support costs depend primarily upon how often and for how long an item is employed, and the accounting procedures used to track expenses - factors which are often highly subjective and not clearly defined. A "training" exercise, for example, may produce a large charge or a small charge, depending upon the method for posting it to the ledger. In order to reduce the uncertainty associated with operational support functions, and add consistency to the cost analysis, the contractor developed lists of questions relating to the extent and frequency of training and operational exercises, duration of deployments, number of "failure" incidents in a year, average number of hours to repair, cost of parts, level of operating and maintaining crews, and so on. Mailing of the lists was followed-up by telephone interviews and site visits to Navy, Army and Marine Corps amphibious personnel. As responses were collected, the data was collated, assessed, and placed in CARD as input. Some of the responses and the assumptions stemming from those responses are fundamental to the credibility of the LCCM. Appendix A contains a list of key statements and assumptions.

Table 11 is a summary of contractor expenses for operational support during Phase III, showing the breakdown of expense for estimated total system cost, estimated annual cost for the system, and estimated annual cost per individual monocoque or intermodal module. Table 12 presents the same format of summary for government operational support expenses.

Table 11. ACBL Contractor Operational Support Summary

Contractor Total		**Annual Cost all Modules**		**Annual Cost per Module**	
(FY 97 $M)		(FY 97 $M)		(FY 97 $M)	
Monocoque	Intermodal	Monocoque	Intermodal	Monocoque	Intermodal
$241.3	$334.6	$24.13	$33.46	$0.014	$0.020
(Then Yr $M)		(Then Yr $M)		(Then Yr $M)	
Monocoque	Intermodal	Monocoque	Intermodal	Monocoque	Intermodal
$314.5	$436.1	$31.45	$43.61	$0.019	$0.026
NOTE: 10 years and 1692 modules		Note: 1 year and 1692 modules		Note: 1 year and 1 module	

Table 12. ACBL Government Operational Support Summary

Government Total		**Annual Cost all Modules**		**Annual Cost per Module**	
(FY 97 $M)		(FY 97 $M)		(FY 97 $M)	
Monocoque	Intermodal	Monocoque	Intermodal	Monocoque	Intermodal
$1183.4	$1611.9	$118.34	$161.19	$0.070	$0.095
(Then Yr $M)		(Then Yr $M)		(Then Yr $M)	
Monocoque	Intermodal	Monocoque	Intermodal	Monocoque	Intermodal
$1518.2	$2066.9	$151.82	$206.69	$0.090	$0.122
NOTE: 10 years and 1692 modules		Note: 1 year and 1692 modules		Note: 1 year and 1 module	

Cost Drivers. The summary of LCC estimates is presented in expanded detail in Tables 13a and 13b in order to amplify the cost drivers. Table 13(a) presents costs in terms of FY97 dollars, while Table 13(b) presents costs in terms of then-year dollars. Each line item is broken down into percent of phase cost as well as percent of total LCC. This table confirms that overhaul cost stemming from periodic contractor and governmental servicing programs is the number one cost driver for both the monocoque (13.34% + 60.65% = **73.99%)** and the intermodal (13.90% + 63.32% = **77.22%**) concepts.

Table 13(a). LCC Cost Drivers in FY97 Dollars

	MONOCOQUE			**INTERMODAL**			**COST DELTA**
FY97	Cost($M)	% of Phase	% of LCC	Cost($M)	% of Phase	% of LCC	(INTER - MONO)
DEVELOPMENT							
LEAD Project	3.65	6.76%	0.19%	3.65	6.25%	0.14%	0.00
Modules-Navy	14.98	27.75%	0.80%	18.91	32.37%	0.74%	3.94
Modules-Army	1.95	3.62%	0.10%	2.47	4.22%	0.10%	0.51
Additional Material	2.90	5.37%	0.15%	2.90	4.96%	0.11%	0.00
Govt. Support	30.49	56.50%	1.63%	30.49	52.20%	1.19%	0.00
Total	53.97	100.00%	2.88%	58.42	100.00%	2.27%	4.45
PRODUCTION							
Modules-Navy	232.07	48.07%	12.38%	346.76	53.23%	13.50%	114.69
Modules-Army	107.21	22.21%	5.72%	161.24	24.75%	6.28%	54.03
Additional Mat'l	22.70	25.42%	6.55%	122.70	18.84%	4.78%	0.00
Govt. Support	20.75	4.30%	1.11%	20.75	3.19%	0.81%	0.00
Total	482.74	100.00%	25.76%	651.46	100.00%	25.36%	168.72
O&S							
Contractor:							
CSE/PSE	0.90	0.37%	0.05%	0.90	0.27%	0.04%	0.00
Overhauls	240.43	99.63%	12.83%	333.74	99.73%	12.99%	93.31
Total	241.33	100.00%	12.88%	334.64	100.00%	13.03%	93.31
Government:							
Deployments	2.71	0.25%	0.14%	2.71	0.18%	0.11%	0.00
Annual Repairs	0.51	0.05%	0.03%	0.51	0.03%	0.02%	0.00
Annual Training	1.18	0.11%	0.06%	1.18	0.08%	0.05%	0.00
CSE/PSE	0.30	0.03%	0.02%	0.30	0.02%	0.01%	0.00
Disposal	0.00	0.00%	0.00%	0.00	0.00%	0.00%	0.00
Overhauls	1,110.99	101.38%	59.29%	1,544.93	101.35%	60.14%	433.94
Salvage	(19.84)	(1.81%)	(1.06%)	(25.23)	(1.66%)	(0.98%)	(5.39)
Total	1,095.85	100.00%	58.48%	1,524.40	100.00%	59.34%	428.54
Total	**$1,873.89**		**100.00%**	**$2,568.92**		**100.00%**	**$695.02**
			LCC ($FY97)				

Table 13(b). LCC Cost Drivers in Then-Year Dollars

	MONOCOQUE			INTERMODAL			COST DELTA
Escalated	Cost($M)	% of Phase	% of LCC	Cost($M)	% of Phase	% of LCC	(INTER - MONO)
DEVELOPMENT							
LEAD Project	3.64	6.14%	0.15%	3.64	5.66%	0.12%	0.00
Modules-Navy	16.87	28.46%	0.72%	21.30	33.14%	0.68%	4.43
Modules-Army	2.20	3.71%	0.09%	2.78	4.32%	0.09%	0.58
Additional Material	3.64	6.14%	0.15%	3.64	5.66%	0.12%	0.00
Govt. Support	32.92	55.55%	1.40%	32.92	51.22%	1.05%	0.00
Total	59.26	100.00%	2.52%	64.27	100.00%	2.05%	5.01
PRO.DUCTION							
Modules-Navy	275.38	48.04%	11.72%	346.76	51.16%	11.08%	71.38
Modules-Army	128.05	22.34%	5.45%	161.24	23.79%	5.15%	33.19
Additional Mat'l	15.79	25.43%	6.21%	145.79	21.51%	4.66%	0.00
Govt. Support	24.02	4.19%	1.02%	24.02	3.54%	0.77%	0.00
Total	573.24	100.00%	24.40%	677.81	100.00%	21.66%	104.57
O&S Contractor:							
CSE/PSE	1.15	0.37%	0.05%	1.15	0.26%	0.04%	0.00
Overhauls	313.31	99.63%	13.34%	44.90	99.74%	13.90%	121.60
Total	314.45	100.00%	13.39%	436.05	100.00%	13.94%	121.60
Government:							
Deployments	3.46	0.25%	0.15%	3.46	0.18%	0.11%	0.00
Annual Repairs	0.66	0.05%	0.03%	0.66	0.03%	0.02%	0.00
Annual Training	1.50	0.11%	0.06%	1.50	0.08%	0.05%	0.00
CSE/PSE	0.38	0.03%	0.02%	0.38	0.02%	0.01%	0.00
Disposal	0.00	0.00%	0.00%	0.00	0.00%	0.00%	0.00
Overhauls	1,424.84	101.62%	60.65%	1,981.38	101.56%	63.32%	556.54
Salvage	(28.67)	(2.04%)	(1.22%)	(36.46)	(1.87%)	(1.17%)	(7.79)
Total	1,402.19	100.00%	59.69%	1,950.93	100.00%	62.35%	548.75
Total	**$2,349.14**		**100.00%**	**$3,129.07**		**100.00%**	**$779.93**

LCC Then Year $

SITE SURVEYS

The joint services hold a significant investment in Navy NL and Army MCS assets. The infrastructure erected to house and support Army and Navy lighters centers around the specific weight, dimensional, and functional characteristics of existing inventories. Site surveys were completed at key Navy, Marine Corps, and Army amphibious support locations during 1996 to identify the potential implications of wholesale replacement by ACB lighters. The primary purpose of the site surveys was to establish a “heads up” notice of long-term planning and funding required for MILCON projects.

Appendix C contains the site survey information, which identifies existing infrastructures used to move, store, launch, repair, and maintain pontoon assets. The locations surveyed were as follows: (1) Navy Amphibious Construction Battalion One (PHIBCBONE), Coronado, California; (2) Navy Amphibious Construction Battalion Two (PHIBCBTWO), Norfolk, Virginia; (3) Army Watercraft Center, Ft. Eustis, Virginia; and, (4) Marine Corps Blount Island Command, Florida. Two apparent deficiencies are the finger piers at the Navy amphibious bases which at 22.5 feet and 24 feet between fingers are not wide enough to handle ACB lighters. Another deficiency at PHIBCBTWO is the entry door and the travel-lift crane servicing the new paint and sandblast facility. Neither is wide enough to handle the 24-foot width of the ACBL. PHIBCBONE is short on capacity for storing pontoons assets on land or water, which poses a particular problem during the transition phase when both NL and ACB assets must be serviced and ready to go. Other key observations and problems, as well as points of contact, are identified in the text.

SUMMARY

The Maritime Prepositioning Force and the Army Prepositioned Afloat programs employ amphibious hardware that currently cannot be used interchangeably for delivering materiel from ship to shore. Neither the NL assets of the Navy nor the MCS assets of the Army meet the emerging operational requirements for sea state 3 operation and accelerated cargo throughput. NFESC has developed the ACBL concept which proposes a modular, high sea state, high payload, barge system for greatly improving the safety and efficiency of ship-to-shore operations. Because the system consists of modules that may be carried within the standard cargo cells of any container ship, it is fully suitable for the prepositioning fleets of both Army and Marine Corps.

A LCCM was constructed for two different configurations of the ACB lighter module. In the monocoque concept, each lighter is comprised of three monolithic steel modules which are offloaded from a container ship for assembly on the water. In the intermodal option, each of the three component modules that makes up a lighter is further broken down into three sub-modules that are assembled dockside prior to loading aboard ship. The intermodal scheme offers the benefit of transportation by conventional methods over road and rail, but requires more materials and increased maintenance. The LCCM forecasts a surplus life cycle cost over 20 years of $780,000,000 if the intermodal option were to be developed. For both alternatives, life cycle expenses resulting from overhaul are the primary cost drivers.

The LCCM was developed using a set of assumptions based on current operating procedures as well as existing training and exercise schedules. Although some of these assumptions may not be totally accurate, and all are subject to change, the beauty of the model is that it is dynamic and responsive to changing inputs, enabling it to be updated as future conditions and funds warrant. Site surveys conducted at key amphibious locations identified existing infrastructures and exposed potential problem areas.

REFERENCES

1. Naval Facilities Engineering Service Center. Contract Report CR96.013: Advanced modular lighterage/platform technology development, by M. Rosenblatt & Son, Inc. New York, NY, 1996.

2. Naval Facilities Engineering Service Center. Contract Report CR97.006: Advanced modular lighterage/platform technology development, phase II final report by M. Rosenblatt & Son, Inc. New York, NY, Jun 1997.

3. Naval Facilities Engineering Service Center. Contract Report CR96.012: Amphibious cargo beaching lighter module design and development, by M. J. Plackett & Associates, Gig Harbor, WA, Oct 1996.

Appendix A

DATA COLLECTION AND ASSUMPTIONS

This appendix documents the efforts of the contractor in collecting maintenance and operational data from the field activities. The organizations contacted included the Navy Amphibious Construction Battalion One (PHIBCBONE) at Coronado, California; Navy Amphibious Construction Battalion Two (PHIBCBTWO) at Norfolk, Virginia; the Naval Support Office at the Marine Corps Blount Island Command, Florida; and the Army Watercraft Center, Ft. Eustis, Virginia. Because of conflicting schedules, the holiday season, and command decisions, not all of the requests for information were honored. A site visit to the Army Watercraft Center was canceled by a command decision, and the contractor was deferred instead to personnel at the Army Transportation Systems Management Office in St. Louis, Missouri. There was subsequently no response to the list of questions provided. PHIBCBONE also did not respond to contractor inquiries because of competing field exercises. Thus the bulk of user input serving to define the nature of maintenance, training, and field operations was derived during a meeting at PHIBCBTWO and during phone dialogue with the Blount Island Command. The various questionnaires and documented responses are contained in this appendix.

In addition to data collected from the user, some assumptions were made by the contractor regarding cost analysis and mission exercises. Diesel engine cost for barge ferries was taken as $492,664 (FY94 dollars), calculated by subtracting the cost of an Army Modular Causeway System (MCS) intermediate section from the cost of a MCS powered section. Using a similar analogy, the estimated cost in FY94 dollars of warping tug diesel engine, winch, and A-frame was estimated by subtracting intermediate section cost from warping tug cost. It was assumed that both Navy MPF and Army APA ships would be involved in 3 missions per year involving 14 modules per mission.

Memorandum

DATE: November 14, 1996

TO: LCDR R. J. Gibbs, USN, ACB2

FROM: Robert Craig, Program Manager and Senior Cost Estimator,
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: PROPOSED AGENDA FOR 11/19/96 MEETING

CC: J. Barthelemy, NFESC, Tel 805 982-1314

At this time, I suggest the following topics for inclusion in our meeting scheduled for 1315, 11/19, Tuesday at ACB2.

- The purpose of our study and the two main types of amphibious cargo beach lighters being considered as replacements for the current generation.
- The type, frequency, and duration of ACB2 training and exercise operations with the current lighters/causeways.
- The number and type of failures experienced (based on either op hours, weekly, monthly, or annually versus the number of units) with the current lighters/causeways.
- The average number of hours to repair the different types of failures, and who performs the repairs.
- If known, the average cost of repair parts.
- The number of personnel (military and civilian) in ACB2) required to operate and maintain the lighters.
- In the opinion of ACB2, how any of the data in the preceding topics might change with the proposed lighters.

If you have any questions or comments please call or fax me at the listed numbers.

Yours truly,

Robert Craig

Memorandum

DATE: November 21, 1996

TO: LCDR R. J. Gibbs, USN, ACB2

FROM: Robert Craig, Program Manager and Senior Cost Estimator,
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: Results of 11/19/96 Meeting

CC: J. Barthelemy, NFESC, Tel 805 982-1314

Thank you very much for meeting with us on 11/19. Please convey our thanks also to LT Mowery, LTJG Christian, Petty Officer Gaspar, and the Chiefs and Petty Officers of B Company. The meeting and tour were very instructive for us and helped us to better understand the tempo and nature of your operations and maintenance. We were also impressed with the military bearing and knowledge of the personnel whom we saw.

- We think we heard the following information, and since it could form the basis for algorithms in the NFESC LCC Model for the Sea State 3 lighters, please correct us if we have anything wrong.

    ACB2 has 33 Navy Lighters (NLs). 11 RO/RO causeway sections, and 9 SLWTs.

    The NLs are each approximately 21-ft wide, 90-ft long, and 5-ft in height.

    The NLs consist of 45 modules or cans, with each being approximately 6-ft 6-in wide, 6-ft long, and 5-ft deep.

    About 590 work-hours (MHrs) are spent each week on the 9 SLWTs for engine/propulsion/hydraulics maintenance.

    About 900 work-hours are spent each week on the 9 SLWTs for deck and hardware maintenance.

    Each NL goes through a comprehensive corrosion control and maintenance period once each year.

    B Company consists of 89 personnel.

    ACB2 craft and causeways are used for MPF ops for periods from one to four weeks.

- We believe agreement was reached that ACB2 would take for action the following questions, if answering did not require excessive work-hours. (This paper restates some of the questions slightly, from the way we expressed them orally in order to increase understanding and precision. If you think providing us the average numbers requested in questions 1-4 will take too much time, could you give us the average number of NLs in the water during the year, and the total engine operating hours for the 9 SLWTs)?

1. The average number of hours (weekly, monthly, or annually; your choice) that an NL spends in training operations locally? (We assume that of the 44 NLs, only a small portion are in the water throughout the year, and thus the average figure would be significantly lower than of the hours spent operating with the actual number of NLs in the water).

2. The average number of NLs actually in the water through the year?

3. The average number of engine operating hours (weekly, monthly, or annually; your choice) that an SLWT spends in training operations locally?

4. The average number of engine operating hours that an SLWT spends in a Fleet exercise (MPF, etc.) operation?

5. The average duration of an MPF operation for the SLWTs? (Would two and a half weeks be a reasonable assumption)?

6. The average number of times (weekly, monthly, or annually; your choice) an NL must be pulled from the water for unscheduled maintenance due to damage or failure of a component.

7. Either the average cost of a repair part or the average cost of materials for repair of an NL? (We believe we have the data for an SLWT).

8. The personnel allowance for C Company?

9. The maximum width of an object (NL, SLWT, new ACBL) which the corrosion control facility crane can straddle and lift?

10. The number of work-hours required to process one NL through the corrosion control/maintenance facility?

- Since the meeting, we have thought of six additional questions for which we would appreciate answers; to wit:

  a. The displacement and shaft horsepower of one of the main propulsion diesels in the SLWT?

  b. The displacement and shaft horsepower of the winch diesel in the SLWT?

  c. The average quantity of fuel consumed per month per one SLWT, or, alternatively, the total amount of fuel consumed per month, or year, for all of the ACB2 craft?

d. The average number of personnel in SIMA normally committed to support of ACB2 craft and causeways? (We understand that this may be a difficult number to precisely quantify, and may be quite low, but we would appreciate your best judgment).

e. The differences of a RO/RO causeway from an NL?

Again thank you very much for your help. If you have any questions or comments please call or fax me at the listed numbers.

Yours truly,

Robert Craig

26 Nov 96

MEMORANDUM

From: LCDR Gibbs, PHIBCB TWO
To: Mr. Robert Craig, CERi

Subj: REQUESTED INFOMATION ON SEA STATE THREE LIGHTERAGE

Ref: (a) Your memo of 14 Nov 96

1. Per your request, I've attached our answers to your questions.

2. Additionally, the average cost to overhaul an SLWT or CSP is $426K and an unpowered section is $350K.

Very respectfully,

R. J. GIBBS

Answers to questions 1 through 10 in CERi's 21 Nov 96 facsimile

1. "The average number of hours that an NL spends in training operations locally?"

You assumed that since only a small portion of the NLs are in the water at any given time, we need to increase the figures if all of the sections were in the water year round. This is basically true, assuming there would ever be a need for all of the sections to be in the water all of the time.

Training is a broad area and can be addressed by summing the hours spent on construction, repair, maintenance, and operational training (time in the water). A crew of 7 personnel for a duration of about 1200 man hours constructs one NL section each year. There are 5 other people dedicated (and another 10 people in various supporting roles) to the repair and maintenance of the NL sections, year round. On the average, there are 120 man hours of maintenance (under the Navy's 3M system) done on each causeway each year. This includes all welding, cutting, hole repairs, and pontoon replacement that is required. Over a year, each causeway section at ACB TWO spends about 4 weeks in the water (this does not include times on exercises, as those sections come off of the MPF ships.)

2. "The average number of NLs actually in the water through the year?"

As stated, each section averages about 4 weeks in the water, throughout the year. This works out to about 3.5 sections being in the water at any given time.

3. Bravo company

4. Bravo company

5. Bravo company

6. "The average number of times an NL must be pulled from the water for unscheduled maintenance due to damage or failure of a component."

May be one section every 4 months - not very often.

7. "Either the average cost of a repair part or the average cost of materials for repair of an NL?"

Obviously this depends heavily on what is damaged. Attached is a list of various repair parts. Generally a standard repair averages about $2,000 in parts.

8. "The personnel allowance for C Company?"

See answer in number 1.

9. “The maximum width of an object which the corrosion control facility crane can straddle and lift?”

The 150 ton AMO straddle lift can lift an object up to 28 feet in width. However, the rail mounted straddle lift in the Blast and Paint Facility can only handle objects 24 feet wide.

10. “The number of work-hours required to process one NL through the corrosion control/maintenance facility?”

It takes a crew of four people about 12 working days to complete the blasting and painting of one NL section.

Answers to additional questions a through e in CERi’s 21 Nov 96 facsimile

a through d: Bravo company

e. “The differences of a RO/RO causeway from an NL?”

A RO/RO section is identical to the intermediate NL causeway sections except:

1. It is 88-ft long, versus 90-ft long
2. It attaches to other RO/RO sections through side “flexors” and not just end to end (like the regular intermediate sections.)

REPAIR PARTS LIST

DESCRIPTION	QUANTITY USED	UNIT COST	TOTAL COST
C1 CLEAT	08	$40	$320
AP1 ASSY PLATE	44	$16	$704
CP1 CHAIN PLATE	04	$60	$240
DECK CLOSURE	50	$160	$8,000
A27 ASSY PLATE	55	$15	$825
AP4A ASSY PLATE	20	$20	$400
A25 A.SSY PLATE	25	$6	$150
A6B ASSY BOLT	750	$7	$5,250
FNI FLANGED NUT	750	$6	$4,500
KPI KEEPER PLATE	300	$9	$2,700
PH10 HOISTING PADEYE	10	$500	$5,000
EXTERNAL SPUDWELL CONNECTOR	16	$250	$4,000
E711 ASSY ANGLE	24	$450	$10,800
901L ASSY ANGLE END	12	$110	$1,320
901R ASSY ANGLE END	12	$130	$1,560
903L ASSY ANGLE END	12	$110	$1,320
903R ASSY ANGLE END	12	$110	$1,320
			$48,409

Memorandum

DATE: November 25, 1996

TO: LT W. C. Newton, USN, Telephone 619 437-3504

SENIOR CHIEF COGGINS please forward to LT Newton

FROM: Robert Craig, Program Manager and Senior Cost Estimator,
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: Questions to support development of Sea State Three Lighters

CC: J. Barthelemy, Naval Facilities Engineering Support Center, Tel 805 982-1314

Your name was given to us by J. Barthelemy, NFESC, as the liaison at ACB1I to handle inquiries to support development of the next generation of lighters, causeways, and tugs. We are under contract to develop a life cycle cost model (LCCM) for the Sea State Three amphibious lighters and causeways. The model will contain algorithms for the two main alternative lighter designs, the intermodal and the monocoque. The reliability of the model will be increased if it contains inputs and algorithms which reflect the requirements and operating conditions of the US Navy and Army. We are in the process of obtaining inputs from ACB2 and the Army Watercraft Center, but we need Inputs from ACB1 to improve the reliability and comprehensiveness of the LCCM.

We have prepared a list of specific questions, the answers to which could form the basis for algorithms in the NFESC LCCM. Please do not hesitate to suggest changes or corrections to the questions to improve the validity of the model.

1. Disregarding Marine Positioning Force (MPF) assets, how many lighters, RO/RO causeway sections, and powered lighters/barges are in the ACB1 organization?

2. What are the physical dimensions of the amphibious lighters, sections, and powered lighters/barges defined above?

3. What are the dimensions of the modules making up the amphibious lighters, sections, and powered lighters/barges defined above?

4. How many Organizational-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

5. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

6. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for unpowered lighters/barges/causeways?

7. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

8. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

9. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck- and hardware maintenance for unpowered lighters/barges/causeways?

10. Is there a comprehensive corrosion control and maintenance period at designated periods for lighters, RO/RO causeway sections, and powered lighters/barges?

11. What are the number of work-hours required to process one lighter through the I or D-Level corrosion control/maintenance facility?

12. What is the maximum width of a lighter or causeway which the I or D maintenance facility cranes can straddle and lift?

13. How many Intermediate or Depot-Level personnel can be attributed to direct support of ACB1 lighters/causeways/powered lighters?

14. How many Organizational-Level personnel, directly associated with the operation and maintenance of lighters/causeways/powered lighters are in ACB1?

15. Do ACB1 lighters/causeways/powered lighters deploy for designated peacetime exercises, and if so, for what duration, and how many times annually?

16. What is the average duration of a deployed operation for the powered lighters/barges?

17. What are the average number of engine operating hours that a powered lighter/barge spends in a deployed exercise or operation?

18. What are the average number of hours (weekly, monthly, or annually; your choice) that an unpowered lighter, etc spends in training operations locally? (We assume that of the total number of lighters, only a small portion are in the water throughout the year, and thus the average figure would be significantly lower than the hours spent operating with the actual number of lighters in the water).

19. What are the average number of lighters actually in the water through the year?

20. What are the average number of powered lighters/barges actually in the water through the year?

21. What are the average number of engine operating hours (weekly, monthly, or annually; your choice) that a powered lighter/barge spends in training operations locally?

22. What are the average number of times (weekly, monthly, or annually; your choice) a lighter or powered lighter/barge must be pulled from the water for unscheduled maintenance due to damage or failure of a component?

23. What is either the average cost of a repair part, or the average cost of materials for repair of a lighter?

24. What is either the average cost of a repair part, or the average cost of materials for repair of a powered lighter/barge?

25. What are the displacement and shaft horsepower of one of the main propulsion diesels in the powered lighters/barges?

26. What is the displacement and shaft horsepower of the winch diesels in the powered lighters/barges?

27. What is the average quantity of fuel consumed per month per one powered lighter/barge, or, alternatively, the total amount of fuel consumed per month, or year, for all of the ACB1 powered lighters?

28. What are the differences between a RO/RO causeway and a lighter?

Please call me at the listed numbers for coordinating information, or explanations of questions which you consider unclear or ambiguous. I regret burdening you with this data request, but if you look at the questions carefully, you may find most of the answers readily at hand. We would appreciate preliminary numbers at least by 5 December 1996. Thank you for your cooperation.

Yours truly,

Robert Craig

Memorandum

DATE: November 25, 1996

TO: CAPT B. J. Gomo, USA, Army Watercraft Center

FROM: Robert Craig, Program Manager and Senior Cost Estimator,
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: Questions for 12/11/96 Meeting

CC: J. Barthelemy, Naval Facilities Engineering Support Center, Tel 805 982-1314
CAPT Boren, USA, Army Watercraft Center, FAX 804 878-4870

We took forward to meeting with you at 0900 on 12/11 at the Army Watercraft Center (AWC). When it is convenient for you, we would appreciate a telephone call with directions on how to reach the AWC.

- As you know we have been tasked to develop a Life Cycle Cost Model (LCCM) for the next generation of Sea State 3 amphibious lighters and causeways. The model will contain algorithms for the two main alternative lighter designs, the intemodal and the monocoque. The reliability of the model will be increased if it contains inputs and algorithms which reflect the requirements and operating conditions of the US Army.

- In order to help you prepare for the meeting, we have prepared a list of specific questions, the answers to which could form the basis for algorithms in the NFESC LCCM. Please do not hesitate to suggest changes or corrections to the questions to improve the validity of the model.

1. Disregarding Army Prepositioned Ship assets, how many lighters, RO/RO causeway sections, and powered lighters/barges are in the AWC organization?

2. What are the physical dimensions of the amphibious lighters. sections, and powered lighters/barges defined above?

3. What are the dimensions of the modules making up the amphibious lighters, sections, and powered lighters/barges defined above?

4. How many Organizational-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

5. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

6. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for unpowered lighters/barges/causeways?

7. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

8. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

9. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for unpowered lighters/barges/causeways?

10. Is there a comprehensive corrosion control and maintenance period at designated periods for lighters, RO/RO causeway sections, and powered lighters/barges?

11. What are the number of work-hours required to process one lighter through the I or D-Level maintenance facility?

12. What is the maximum width of a lighter or causeway which the I or D maintenance facility cranes can straddle and lift?

13. How many Intermediate or Depot-Level personnel can be attributed to direct support of AWC watercraft?

14. How many Organizational-Level personnel are in the AWC?

15. Do AWC lighters and causeways deploy for designated peacetime exercises, and if so, for what duration, and how many times annually?

16. What is the average duration of a deployed operation for the powered lighters/barges?

17. What are the average number of engine operating hours that a powered lighter/barge spends in a deployed exercise or operation?

18. What are the average number of hours (weekly, monthly, or annually; your choice) that an unpowered lighter, etc spends in training operations locally? (We assume that of the total number of lighters, only a small portion are in the water throughout the year and thus the average figure would be significantly lower than the hours spent operating with the actual number of lighters in the water).

19. What are the average number of lighters actually in the water through the year?

20. What are the average number of powered lighters/barges actually in the water through the year?

21. What are the average number of engine operating hours (weekly, monthly, or annually; your choice) that a powered lighter/barge spends in training operations locally?

22. What are the average number of times (weekly, monthly, or annually; your choice) a lighter or powered lighter/barge must be pulled from the water for unscheduled maintenance due to damage or failure of a component?

23. What is either the average cost of a repair part or the average cost of materials for repair of a lighter?

24. What is either the average cost of a repair part, or the average cost of materials for repair of a powered lighter/barge?

25. What are the displacement and shaft horsepower of one of the main propulsion diesels in the powered lighters/barges?

26. What is the displacement and shaft horsepower of the winch diesels in the powered lighters/barges?

27. What is the average quantity of fuel consumed per month per one powered lighter/barge, or, alternatively, the total amount of fuel consumed per month, or year, for all of the AWC craft?

28. What are the differences between a RO/RO causeway and a lighter?

If you have any questions or comments please call or fax me at the listed numbers.

Yours truly,

Robert Craig

Memorandum

DATE: December 6, 1996

TO: Mr. Tom Smith, Chief, Trans Sys Management Office, 314 263-6623

FROM: Robert Craig, Program Manager and Senior Cost Estimator
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: Questions for SEA STATE THREE MODULAR CAUSEWAY SYSTEM

CC: J. Barthelemy, Naval Facilities Engineering Support Center**,** Tel 805 982-1314
LTC Davis, USA, 7th Trans Bn, Ft Eustis, VA, FAX 804 878-4870

This follows up on our telephone conversation of 6 Dec.

- As you know we have been tasked to develop a Life Cycle Cost Model (LCCM) for the next generation of Sea State 3 amphibious lighters and causeways. The model will contain algorithms for the two main alternative lighter designs, the intermodal and the monocoque. The reliability of the model will be increased if it contains inputs and algorithms which reflect the requirements and operating conditions of the US Army.

- We have prepared a list of specific questions. the answers to which could form the basis for algorithms in the NFESC LCCM. Please do not hesitate to suggest changes or corrections to the questions to improve the validity of the model.

1. Disregarding Army Prepositioned Afloat (APA) assets, how many lighters, RO/RO causeway sections, and powered lighters/barges are in other Army organizations?

2. What are the physical dimensions of the amphibious lighters, sections, and powered lighters/barges defined above?

3. What are the dimensions of the modules making up the amphibious lighters, sections, and powered lighters/barges defined above?

4. How many Organizational-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

5. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

6. How many Organizational-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for unpowered lighters/barges/causeways?

7. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on engine/propulsion/hydraulics maintenance for the powered lighters/barges?

8. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for the powered lighters/barges?

9. How many Intermediate or Depot-Level work-hours (MHrs) are spent each week on deck and hardware maintenance for unpowered lighters/barges/causeways?

10. Is there a comprehensive corrosion control and maintenance period at designated periods for lighters, RO/RO causeway sections, and powered lighters/barges?

11. What are the number of work-hours required to process one lighter through the I or D-Level maintenance facility?

12. What is the maximum width of a lighter or causeway which Army I or D maintenance facility cranes can straddle and lift?

13. How many Intermediate or Depot-Level personnel can be attributed to direct support of other than APA Army watercraft?

14. How many Organizational-Level personnel are in other than APA Army watercraft organizations?

15. Do other than APA lighters and causeways deploy for designated peacetime exercises, and if so, for what duration, and how many times annually?

16. What is the average duration of a deployed operation for the powered lighters/barges?

17. What are the average number of engine operating hours that a powered lighter/barge spends in a deployed exercise or operation?

18. What are the average number of hours (weekly, monthly, or annually; your choice) that an unpowered lighter, etc., spends in training operations locally? (We assume that of the total number of lighters, only a small portion are in the water throughout the year and thus the average figure would be significantly lower than the hours spent operating with the actual number of lighters in the water).

19. What are the average number of lighters actually in the water through the year?

20. What are the average number of powered lighters/barges actually in the water through the year?

21. What are the average number of engine operating hours (weekly, monthly, or annually; your choice) that a powered lighter/barge spends in training operations locally?

22. What are the average number of times (weekly, monthly, or annually; your choice) a lighter or powered lighter/barge must be pulled from the water for unscheduled maintenance due to damage or failure of a component?

23. What is either the average cost of a repair part, or the average cost of materials for repair of a lighter?

24. What is either the average cost of a repair part, or the average cost of materials for repair of a powered lighter/barge?

25. What are the displacement and shaft horsepower of one of the main propulsion diesels in the powered lighters/barges?

26. What is the displacement and shaft horsepower of the winch diesels in the powered lighters/barges?

27. What is the average quantity of fuel consumed per month per one powered lighter/barge or, alternatively, the total amount of fuel consumed per month or year, for all of other than APA Army water craft?

28. What are the differences between a RO/RO causeway and a lighter?

We greatly appreciate your help in this matter. If you have any questions or comments please call or fax me at the listed numbers.

Yours truly,

Robert Craig

Memorandum

DATE: December 11, 1996

TO: Mr. Jerry Voynik, Head, Naval Support Office, 904-696-5228
Mr. Cary Brewer, 904-696-5373, 904-251-1741

FROM: Robert Craig, Program Manager and Senior Cost Estimator,
CERi, Tel 703 271-6540, FAX 703 979-7554

RE: Questions for SEA STATE THREE MODULAR CAUSEWAY SYSTEM

CC: J. Barthelemy, Naval Facilities Engineering Support Center, Tel 805 982-1314

This follows up on our telephone conversation of 10 Dec.

- As you know we have been tasked to develop a Life Cycle Cost Model (LCCM) for the next generation of Sea State 3 amphibious lighters and causeways.

- We have prepared a list of specific questions, the answers to which could form the basis for algorithms in the NFESC LCCM. Please do not hesitate to suggest changes or corrections to the questions to improve the validity of the model.

1. How many lighters, RO/RO causeway sections, and powered lighters/barges are maintained or transition annually through the BIC organization?

Port		Deployed	Total
Powered		Non-Powered	
SLWT	Brg Frry	NL	
19	75	104	198

(every 42 days (8 hr consecutive calendar days); 14 craft processed)

2. How many work hours are involved with off-load from MPF ships of the amphibious lighters, sections, and powered lighters/barges defined above?

2,725 hrs/yr 3,312 hrs/yr

3. How many work hours are involved with load-out in the MPF ships of the amphibious lighters, sections, and powered lighters/barges defined above?

2,520 hrs/yr 3,312 hrs/yr

4. How many work hours are involved in actual performance of maintenance by BIC personnel on the amphibious lighters, sections, and powered lighters/barges defined above?

49,929 hrs/yr	32,448 hrs/yr

5. How many personnel at BIC are devoted to support of the amphibious lighters, sections, and powered lighters/barges defined above? If you cannot split out the average number of personnel dedicated to support the lighters, is it possible to allocate a percentage of the total time of those personnel focused on the lighters, etc? Please provide the numbers for the following three categories of personnel.

	No. of Personnel	Percent of Time
Military	20 (2 Lts, 1 CPO, 17 E2/E3)	5%
Civilian	3 (1 GS 13, 2 GS 11)	100%
Contractor	37 (@$20./hr, 1.5 for OT)	100%

6. If the number of lighters supported were to change by a given percentage (you provide the percentage) how would the number of personnel at BIC change?

If 100 NL grew to 150, would need 25% increase in personnel

We greatly appreciate your help in this matter. If you have any questions or comments please call or fax me at the listed numbers.

Additional Information:

Exercises: 1 exercise/squadron/yr involving 1 full ship, with offload 14 NIs

MPS: 3 squadrons, 13 ships; LANT 4 ships; PAC 5 ships; IO 4 ships

Yours truly,

Robert Craig

Memorandum

DATE: December 4, 1996

TO: LCDR R J. Gibbs, USN, ACB2

FROM: Robert J. Craig, Program Manager and Senior Cost Estimator, CERi, Tel (703) 271-6540, FAX (703) 979-7554

SUBJ: Sea State Three Lighterage Cost Information

CC: J. Barthelemy, NFESC, Tel (805) 982-1314

Thank you for the fax of 26 Nov 96 supplying us with answers to our questions of 14 Nov 96. In this memo I will summarize the cost information you supplied to us (hi-lighted in bold print) and ask some questions that will help us clarify some cost issues.

Quantity and Description of Navy Lighterage at ACB2

33 Navy Lighters	**21-ft wide, 90-ft long, 5-ft high**
11 RO/RO Causeways	**21-ft wide, 88-ft long, 5-ft high**
09 SLWTs	**21-ft wide, 90-ft long, 5-ft high**

Training

You state – "**Training is a broad area and can be addressed by summing the hours on construction, repair, maintenance and operational training."**

I interpret this statement to mean that all training is on the job training (OJT). Is there any formal, structured training in a classroom for operation or maintenance at ACB2?

Of the data you supplied I have assumed the following for training:

1,200 man hrs/year – construction of one new NL section (21- by 90- by 5-ft?) per year

4 weeks in water/section/year or 3.5 sections/week in water for operational training
However, I can't determine the number of man hrs/year involved in ops training from this data.

I would like the average pay grade (E1, E2, E3, etc) of those 1,200 man hrs for construction and the average pay grade and number of man hrs for operational training.

Repair & Maintenance

Labor (welding, hole repairs and pontoon replacement) – **120 man hrs/year/NL** or 120 man hrs x (33 NL + 11 RO/RO) = 5,280 man hrs/year.

Material (damaged or failed components) **–1 section every 4 months** or 3 sections/yr @**$2K ea** =$6K/year

Again, I would like the average pay grade of the 120 man hrs for labor repair.

You state – **"There are 5 other people dedicated (and another 10 people in various supporting roles) to the repair and maintenance of NL sections, year round."** That equates to 15 man years per year or 15 x 1,800 man hrs/man yr = 27,000 man hrs/year to repair and maintenance of NL sections. Which number is correct – the 5,280 or 27,000 man hrs/year for repair and maintenance labor or is the 5,280 contained in the 27,000. (Note: the 1,800 man hrs/man yr was determined by assuming 52 wks less 4 wks leave less 1 wk sick leave less 2 wks holidays = 45 wks x 40 hrs/wk).

Sand Blast & Paint

4 people x 12 days/section = 48 man days/section or 48 8 hrs/man day = 384 man hrs/section

Overhaul

$426K – for SLWT or for powered causeway (CSP)
$350K – unpowered causeway (CS)

Is the Sand Blast & Paint work part of the Overhaul which is done annually? If it is, I assume that the Sand Blast & Paint labor and material cost is contained in the Overhaul cost. If it is not, I need the labor average pay grade and material costs for Sand Blast & Paint.

Salvage Value

Availability of cost data on salvage value of a NL was mentioned at the Nov 19^{th} meeting. Could we get that please?

MPF

How frequently and how many ACB2 assets (people and NLs, if any), are used in exercises with MPF ships? Do ACB2 NLs ever become exchanged for MPF NLs, or once a NL enters a deployment domain (i.e. ACB or MPF) it remains there for the duration of its life cycle?

Peculiar Support Equipment (PSE), Common Support Equipment (CSE)

How much is spent annually for PSE and CSE?

Other Maintenance

How much is spent annually on maintaining the cranes at ACB2?
How much is spent annually on maintaining the corrosion control facility at ACB2?

Again thank you very much for your help. If you have any questions or comments please call or fax me at the listed numbers.

Yours truly,

Robert J. Craig

Appendix B

ESTIMATED FABRICATION COSTS

One important input to the Amphibious Cargo Beaching Lighter Life Cycle Cost model is the price of fabricating a completed lighter. During 1996, three local marine steel fabricators were solicited to develop fabrication cost elements for both the intermodal module and the monocoque module based on data and schedule provided by NFESC. Of the three vendors who agreed to issue a quotation, one never did respond and a second prepared an analysis that was poorly conceived and inaccurate. The third vendor, however, Maritime Contractors Incorporated, reported a detailed breakdown of estimated costs for modules and connectors, complete with a list of assumptions based on experience in modular construction. That report is included as an integral part of this appendix.

Calculated costs were based on the delivery of 43 completed lighters over a schedule of 8 years. Based on numbers provided by Maritime Contractors Incorporated, the "average" cost of lighters constructed from intermodal modules or monocoque modules are as follows:

Intermodal Lighter. The intermodal lighter consists of three modules, each of which is further broken down into 3 sub-modules, for a total of 9 intermodal modules. Each completed lighter has 8 rigid connectors on module ends and 6 rigid connectors on module sides, for a total of 14 rigid connectors. ln addition, each completed lighter has 4 flexible connectors located on the two ends.

9 intermodal modules @ $68,820 per module	=	$619,380
14 rigid connectors @ $12,352 per connector	=	172,928
4 flexible connectors @ $6,500 per connector	=	26,000
TOTAL cost per intermodal lighter	=	**$818,308**

Monocoque Lighter. The monocoque lighter consists of three modules. Each completed lighter has 8 rigid connectors on module ends and 6 rigid connectors on module sides, for a total of 14 rigid connectors. In addition, each completed lighter has 4 flexible connectors located on the two ends.

3 monocoque modules @ $149,956 per module	=	$449,868
14 rigid connectors @ $12,352 per connector	=	172,928
4 flexible connectors @ $6,500 per connector	=	26,000
TOTAL cost per monocoque lighter	=	$**648,796**

MARITIME CONTRACTORS, INC.
610 WEST HUENEME ROAD
OXNARD, CA 93033
(805) 986-8512
FAX (805) 986-8517

17 October 1996

Mr. Monte Faust
Naval Facilities Engineering Service Center
Code ESC32
1100 23rd Avenue
Port Hueneme, CA 93043-4370

Subject: ***Fabrication Cost Estimates for The Amphibious Cargo Beaching Lighter (Monocoque and Intermodal Concepts)***

Dear Mr. Faust:

Maritime Contractors Incorporated is pleased to provide the enclosed information for above noted subject. For your convenience we are providing you with two copies.

Should you have any questions or desire additional information and/or clarifications, please contact myself or Phil Hopkins at our facility.

MCI thanks you for the opportunity to work with NFESC Port Hueneme. We look forward to working with you on future projects.

Regards,

Brian L. Crankshaw
MCI/VCF Gen. Mgr.

cc: Phil Hopkins (P&E Mgr.)

REQUEST FOR FABRICATION COST ESTIMATES

The Amphibious Cargo Beaching Lighter: Monocoque and Intermodal Concepts

BACKGROUND

The basic building block used in the assembly of conventional Navy pontoon structures is the Navy Lightered (NL) pontoon, a hollow, rectangular, watertight, internally-reinforced steel box that is 5 feet wide by 7 feet long by 5 feet high. Some of the most commonly used pontoon structures, including barges (i.e., lighters) and individual sections of floating causeway pier, are configured around a basic "three string" module that is 3 pontoons wide by 15 pontoons long, giving nominal dimensions of 21 feet by 90 feet. A typical "three string" NL causeway section is shown in Figure 1. A logistical drawback to this existing technology is that each large pontoon structure must be preassembled using bolt-together construction, and then transported aboard a dedicated ship. Since current downsizing of the fleet includes deactivating required LST-type vessels in favor of standard commercial containerships, the development of a replacement Navy lighter technology encompasses concepts for ISO-compatible, "container-sized" modules, that can be assembled into barges on the open seas.

The Naval Facilities Engineering Service Center (INFESC) is advancing the Amphibious Cargo Beaching (ACB) lighter concept as the basis for the next generation of Navy lighterage. A triad of ISO-compatible modules, each sized nominally at 24 feet in width, 40 feet in length, and 8 feet in depth, provides the fundamental building blocks necessary to assemble a basic 120-foot long platform barge, or a family of larger structures, on the water. The continuous deck surface produced by rigidly joining three pontoon modules in fixed end-to-end articulation provides improved hydrodynamic stability and greater flexibility in cargo layout. Wider platforms, when required, are assembled by joining one or more barges together rigidly using the same connector system in a side-to-side application. A group of assembled barge platforms may be linked on the water using flexible-type connectors to form a variety of extended strictures, including barge trains and causeway piers, as intimated in Figure 2.

NFESC has identified two concepts of modularization for possible development as the next Navy lighter. In the **"monocoque"** vision, each 40 ft by 24 ft by 8 ft module is fabricated as a monolithic steel structure, fully assembled for loading aboard a waiting container ship. In the

"intermodal" vision, each steel module is assembled dockside, prior to loading aboard a containership, from three ISO-configured sub-modules, each sized 40 ft by 8 ft by 8 ft. Thus, the intermodal alternative offers the flexibility of truck or train delivery from inland fabricators, while construction and movement of monocoque hardware is essentially limited to coastal locations. The two concepts are pictured side by side in Figure 3.

The monocoque concept is explored in a contract report issued (Enclosure 1) by M. Rosenblatt & Son, Inc., in December 1995. In that report, the preliminary structural design of a monolithic steel module is investigated in order to establish the feasibility of producing a light but durable hull structure limited to approximately 67,200 pounds. The intermodal concept, or Tri-Module configuration as it is also referred to, is explored in a contract report (Enclosure 2) issued by M.J. Plackett & Associates, also in December 1995. That report recommends plating and frame sizes for the smaller 40 foot by 8 foot by 8 foot Tri-module.

The Navy is conducting a preliminary Life Cycle Cost (LCC) analysis of these competing concepts that includes estimates of material and fabrication cost as input. The two reports referenced above are preliminary concept studies, and aside from identifying structural shapes and sizes, they consider few other fabrication factors such as: (1) selection of materials, surface preparation and coating; (2) detail design and welding plan; (3) assembly tolerances, jigging and tooling; (4) specification of module connectors, ISO corners, lift points, deck tie-downs and mooring bits; and (5) production quantity and period of performance. **Conceding that fabrication uncertainties will likely prompt subjective disparity between production estimators, a Rough-Order-of-Magnitude (ROM) costing comparison is nonetheless requested, for which the following technical considerations should be used as a guideline:**

1. The monocoque design is sized assuming A572, grade 50 or equal steel (50,000 psi yield strength), while the intermodal design is sized assuming a mild steel (30,000 psi yield strength). These steels are the materials that should be priced in the cost estimates. Abrasive blast cleaning (SSPC SP-10) is recommended to prepare exterior surfaces to near white conditions, as required before the application of the water-borne, zinc-rich inorganic paint that is the coating of choice for new Navy causeway sections. Steel costs, surface preparation and painting should be identified as line items on the estimate.

2. There is no welding plan at this time. However, common sense and experience should prevail. Pontoon structures are exposed continuously to the highly-corrosive atmosphere characteristic of the marine environment, and the application of skip welds during fabrication will produce crevice areas that promote corrosion. Continuous-weld fabrication is the preferred procedure. Further, since weight minimization is considered a premium, the requirement is for "efficient," high quality welds. Welding costs should be listed as a best "guesstimate" line item, or range of estimates for assumptions made.

3. Jigs and tooling are unavoidable, given that the placement of structural pockets for module connectors and the location of ISO comers require that strict tolerances be maintained. Close tolerance fittings should be added after most welding has been completed because of progressive distorting resulting from continued hot work. The highs and lows of estimates for tooling and jig costs, or single best "guesstimate," should be listed as a line item with any qualifying assumptions stated.

4. The connector system for rigidly joining modules end-to-end and side-to-side is being developed by NFESC. An important and novel detail of this concept is the housing of connector hardware within a modular, self-contained, universal mount. Each identical mount is removable, replaceable, and fully interchangeable within a structural, watertight pocket located on an end or side of a monocoque or intermodal module. Thus, a connector mount may be inverted to the "pin up" or the "pin down" position, respectively, for placement in port or starboard pocket, as illustrated in Figures 4 and 5. The connector pin is backed by a reaction cannister so that during encounters with adjacent module (prior to mating), the pin behaves as a fender, retracting to cushion the effects of collision. The rigid connector is still in the developmental stage so that the drawings provided as part of this package identify key structural members and assemblies, but do not fix steel types or welding procedures. **Estimates of connector module cost and weight should be prepared based on experience, judgement and details in the engineering drawings attached.**

The cost of ISO comers, lift points, deck tie-downs and mooring bits should remain essentially constant, irregardless of how and where a module is made. Thus for purposes of comparing designs, these costs are not required. However, to assist in the calculation of total system cost, estimates and recommendations based on insight, experience and technical judgement are fully appreciated.

6. For purposes of amortizing the cost of tooling and other fixed expenses, and factoring in savings resulting from the production “learning experience," it may be assumed that 43 completed causeway sections (i.e., 129 monocoque modules, or 387 intermodal sub-modules) are delivered over a period of 8 years.

ENCLOSURES

1. Final Report: Advanced Modular Lighterage Platform Technology Development by M. Rosenblatt and Sons. <u>Select pages and figures only</u>.

2. Final Report: U.S. Navy Amphibious Cargo Beaching Lighter Module Design and Development by M.J. Plackett & Associates. <u>Select pages and figures only</u>.

3. Detail drawings of the modular rigid connector system being developed by NFESC.

Cost Estimate for Cargo Lighters
Intermodal Type

Based on our experience in modular construction, the assumptions made for this estimate for fabrication of the individual modules is as follows:

1. It is assumed that the detailed design is complete to the degree necessary to obtain computer lofting tapes.
2. All steel is purchased from the Steel Service Center cut to exact size and shape for construction. This increases the cost of the steel but reduces labor costs in fabrication.
3. All steel is wheelabrated and primed with weld through primer.
4. Loading of the modules for shipping has not been included in this estimate.
5. QA consists of visual inspections of welding and fitup and air testing of the individual units for water-tightness.
6. After construction, testing and painting, the modules will be hooked together in a causeway unit to ensure proper fitup.
7. Based on the preliminary design, each unit will have 3 bolted manhole hatches for access to watertight compartments.
8. Price increases for steel and paint have been factored in at 2-1/2% per year.
9. The following paint system was estimated:
    - INTERIOR:
        - a Prep steel to SSPC-SP-3.
        - b Apply 1 coat, Zinc rich primer, 2-4 mils DFT to bare steel.
        - c Apply 1 coat, Form 150, 6 mils DFT entire interior.
    - EXTERIOR:
        - a Hand prep welds to bare metal
        - b Apply 1 coat Form 150, 4 mils DFT
        - c Apply 1 coats Form 151, 5 mils DFT
        - d Apply 1coats Form 154, 2-4 mils DFT
10. Lofting was estimated at a one time cost of $25,000
11. Jigs and patterns were estimated at a one time cost of $25,000
12. Rigid connectors were estimated at the same amount used on the monocoque causeways.
13. Prices for deck fittings & manholes were not bid. Labor for installation of deck fittings and manholes was bid as a separate line item.
14. All labor was priced at $40/hr.
15. Price for materials and labor for the fenders is not included.
16. Allowance has been made for a learning curve in construction labor. The labor quantity is based on historical data from the Washington State Ferry (WSF) construction project. It is based on a production rate of 30 lbs per hour to start, increasing to 33 lbs per hr over the course of 3 years.

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COST ESTIMATE FOR CARGO LIGHTERS: INTERMODAL TYPE

STEEL: A-36 MILD STEEL
ALL STEEL PRE-CUT AT THE FACTORY
ALL STEEL W/P WITH WELD THRU ZINC PRIMER
INFLATION HAS BEEN FACTORED IN AT 2.5%/YEAR

YEAR	# CAUSE WAYS	# UNITS	WEIGHT / UNIT	WEIGHT	STEEL $/LB	TOTAL STEEL $
1	6	54	32000	1728000	$0.55	$950,400
2	5	45		1440000	$0.56	$810,720
3	5	45		1440000	$0.58	$835,200
4	6	54		1728000	$0.59	$1,019,520
5	5	45		1440000	$0.60	$864,000
6	5	45		1440000	$0.62	$892,800
7	6	54		1728000	$0.64	$1,097,280
8	5	45		1440000	$0.65	$936,000
TOTAL	43	387		12,384,000	$0.60	$7,405,920

YEAR	# UNITS	LABOR WEIGHT	learning curve LABOR /UNIT	LABOR HRS @ 30 LBS/HR	PAINT HRS/UNIT	PAINT HRS/TOTAL	total gals	inflation @ 2.5%/yr price /gal	total paint
1	54	1728000	1067	57600	96	5184	3780	$18.50	$69,930
2	45	1440000	1032	46452	96	4320	3150	$18.96	$59,724
3	45	1440000	1000	45000	96	4320	3150	$19.43	$61,205
4	54	1728000	1000	54000	96	5184	3780	$19.91	$75,260
5	45	1440000	970	43636	96	4320	3150	$20.40	$64,260
6	45	1440000	970	43636	96	4320	3150	$20.91	$65,867
7	54	1728000	970	52364	96	5184	3780	$21.43	$81,005
8	45	1440000	970	43636	96	4320	3150	$21.96	$69,174
TOTAL	387	12384000		386324		37152	27090		$546,424
EST-3840 SQ FT/UNIT							paint supplies $2/hr		$74,304
								total	**$620,728**

			total	per unit	
	steel		$7,405,920	$19,137	
	paint/supplies		$620,728	$1,604	
	weld hrs @ 40	386324	$15,452,960	$39,930	
	paint hrs @ 40	37152	$1,486,080	$3,840	
	weld supplies		$967,500	$2,500	
	jigs/patterns		$25,000	$65	$25,000
	lofting		$25,000	$65	$25,000
	dk fittngs install	7740	$309,600	$800	20 hrs ea
	testing	8514	$340,560	$880	22 hrs ea
	total	439730	$26,633,348	$68,820	
16	rigid connectors		$197,632	$12,352	
4	flex connectors		$26,000	$6,500	

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Cost Estimate for Cargo Lighters
Monocoque Type

Based on our experience in modular construction, the assumptions made for this estimate for fabrication of the individual modules is as follows:

1. It is assumed that the detailed design is complete to the degree necessary to obtain computer lofting tapes.
2. All steel is purchased from the Steel Service Center cut to exact size and shape for construction. This increases the cost of the steel but reduces labor costs in fabrication.
3. All steel is wheelabrated and primed with weld through primer.
4. Loading of the modules for shipping has not been included in this estimate.
5. QA consists of visual inspections of welding and fitup and air testing of the individual units for water-tightness.
6. After construction, testing and painting, the modules will be hooked together in a causeway unit to ensure proper fitup.
7. Based on the preliminary design, each unit will have 3 bolted manhole hatches for access to watertight compartments.
8. Price increases for steel and paint have been factored in at 2-1/2% per year.
9. The following paint system was estimated:
    INTERIOR:
        a Hand prep welds to bare metal.
        b Apply 1 coat, Zinc rich Primer, 2-4 mils DFT to bare steel.
        c Apply 1 coat, Form 150, 6 mils DFT entire interior.
    EXTERIOR:
        a Prep steel to SSPC-SP-3.
        b Apply 1 coats Form 150, 4 mils DFT
        c Apply 1 coats Form 151, 5 mils DFT
        d Apply 1 coats Form 154, 2-4 mils DFT
10. Lofting was estimated at a one time cost of $25,000
11. Jigs and patterns were estimated at a one time cost of $25,000
12. Prices for deck fittings & manholes were not bid. Labor for installation of deck fittings and manholes was bid as a separate line item.
13. All labor was priced at $40/hr.
14. Price for materials and labor for the fenders is not included.
15. Allowance has been made for a learning curve in construction labor. The labor quantity is based on historical data from the Washington State Ferry construction project. It is based on a production rate of 30 lbs per hour to start, increasing to 33 lbs per hr over the course of 3 years.
16. The cost of steel for the Monocoque style, ASTM A-572 Grade 50, is approximately $.04 per lb greater than ASTM A-36.

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COST ESTIMATE FOR CARGO LIGHTERS: MONOCOQUE TYPE

STEEL: A-572 GRADE 50 APPROX $.04/LB GREATER THAN A-36
ALL STEEL PRE-CUT AT THE FACTORY
ALL STEEL W/P WITH WELD THRU ZINC PRIMER
INFLATION HAS BEEN FACTORED IN AT 2.5%/YEAR
STEEL PRICE IS BASED ON CURRENT WS FERRY STEEL PRICES

YEAR	# CAUSE WAYS	# UNITS	WEIGHT / UNIT	WEIGHT	STEEL $/LB	TOTAL STEEL $
1	6	18	66860	1203480	$0.59	$710,053
2	5	15		1002900	$0.60	$604,749
3	5	15		1002900	$0.62	$621,798
4	6	18		1203480	$0.63	$758,192
5	5	15		1002900	$0.64	$641,856
6	5	15		1002900	$0.66	$661,914
7	6	18		1203480	$0.68	$812,349
8	5	15		1002900	$0.69	$692,001
TOTAL	43	129		8,624,940	$0.64	$5,502,912

		LABOR	learning curve					inflation @ 2.5%/yr	
YEAR	# UNITS	WEIGHT	LABOR /UNIT	LABOR HRS @ 30 LBS/HR	PAINT HRS/UNIT	PAINT HRS/TOTAL	total gals	price /gal	total paint
1	18	1203480	2229	40116	212	3816	4049	$18.50	$74,898
2	15	1002900	2157	32352	212	3180	3374	$18.96	$63,967
3	15	1002900	2089	31340.625	212	3180	3374	$19.43	$65,553
4	18	1203480	2089	37608.75	212	3816	4049	$19.91	$80,607
5	15	1002900	2026	30391	212	3180	3374	$20.40	$68,826
6	15	1002900	2026	30391	212	3180	3374	$20.91	$70,546
7	18	1203480	2026	36469	212	3816	4049	$21.43	$86,761
8	15	1002900	2026	30391	212	3180	3374	$21.96	$74,089
TOTAL	129	8624940		269059		27348	29015		$585,246
11246 T SQ FT/UNIT							paint supplies $2/hr		$58,029
								total	**$643,276**

	total hrs	total	per unit		
steel		$5,502,912	$42,658		
paint/supplies		$643,276	$4,987		
weld hrs @ 40	269059	$10,762,352	$83,429		
paint hrs @ 40	27348	$1,093,920	$8,480		
weld supplies		$672,647	$5,214		
jigs/patterns		$25,000	$194	$	25,000
lofting		$25,000	$194	$	25,000
dk fittngs install	7224	$288,960	$2,240		56 hrs ea
testing hrs/unit	8256	$330,240	$2,560		64 hrs ea
total	311887	$\boxed{\$19,344,307}$	$149,956		

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rigid connectors

16	rigid connectors	$197,632
4	flex connectors	$26,000

materials

		qty	matl cost	total	labr
roller assy	ea	14	$30.00	$420	8
washer, 11/16"	ea	32	$0.50	$16	
nut, 5/5 zinc	ea	32	$0.50	$16	
bar, 5/8 x 11 "	ea	14	$3.00	$42	
spring pin	ea	4		$0	
bar, rnd 1x 1'4" (lever rod)	ea	3	$4.00	$12	6
bar,rnd 1x1'10" (lever shft	ea	1	$8.00	$8	2
guillotine assy	ea	1	$120.00	$120	8
handle assy	ea	1	$125.00	$125	9
lever assy	ea	2	$25.00	$50	6
PIN CASE				$0	
tube, 15-3/4" x 2' 6"	ea	1	$125.00	$125	8
plt, 3/4" x 2 sq ft	lb	62	$1.00	$62	3
plt, 1" x 2 sq ft	lb	82	$1.00	$82	3
tube, 10-3/4" od	ft	1	$75.00	$75	2
bar, 3/4 x 3"	ea	2	$2.50	$5	1
Assy of parts				$0	4
NOSE				$0	
tube, 15" x 14-1/4" id	ea	1	$75.00	$75	1
pipe, 12" x strong,stub end fttn	ea	1	$245.00	$245	1
tube, 12-3/4 od	est	1	$75.00	$75	6
rnd bar, 12-3/4" od x 1'	lb	454	$1.00	$454	6
plt, 3/8"	lbs	15.3	$1.00	$15	3
assy of parts				$0	12
pvc cap		1	$75.00	$75	4
rod		1	$20.00	$20	2
fasteners		1	$25.00	$25	
pin plt		1	$25.00	$25	2
spring		1	$715.00	$715	
frame		1	$250	$250	32
assemble unit					40
paint		1	$25		4
	sub-total			**$3,132**	**173**
	total 10% - 40/hr			$3,446	$6,920
	total				**$10,366**

Building a large number of rigid connectors would reduce the cost of labor. The cost of matls would rise over 8 years. The final unit price reflects a 30% reduction in labor and a 16% increase in materials.	$3,997	$4,844
		$\boxed{\$8,841}$

rigid connector pocket/lid installation estimate

steel	lbs	1500	0.65	$ 975	
misc		1	$ 200.00	$ 200	
labor, fab/install					74
paint					12
sub-total				$ 1,175	86
			x 10% $40/hr	$ 118	$ 3,440
total				$ 1,293	$ 4,733
less 20% for production efficiency					**$ 3,786**
total per installed rigid connector					**$ 12,627**

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Appendix C

Site Surveys of Current DoD Pontoon Assets

Introduction

The current generation of Navy Lighters (NL) is nearing the end of its life cycle. The Navy is now looking at alternative systems for replacing these lighters. One of these alternatives is the Amphibious Cargo Beaching Lighter (ACBL) for which one of the factors driving design is cost. This report lists the equipment at four military sites that would be necessary to maintain the ACBL inventory. This report discusses the extent of equipment modification required to implement the ACBL program at these sites.

The information in this report was gathered by performing visits to all the sites that currently maintain the Navy's NL force: Amphibious Construction Battalion One (PHIBCBONE) located at Coronado, California; Amphibious Construction Battalion Two (PHIBCBTWO) located at Norfolk, Virginia; and the Marine Corps Blount Island Command (BIC) located in Florida. Due to the "jointness" of the ACBL program, the Army's causeway system at Ft. Eustis, Virginia, was also sighted. The following table summarizes the equipment sighted at these facilities. Details on the equipment and other information on the impact of the ACBL are discussed in the sections applicable to each facility.

Points of contact for each of the facilities is provided.

Table C-1. List of Amphibious Assets

Equipment	**Navy PHIBCBONE**	**Navy PHIBCBTWO**	**Army Ft Eustis**	**BIC Shipyard**	**BIC BI**
Stratolift Crane	2	2	1	0	2*
Boom Crane	4	1	1	1	0
Finger Pier	1	1	0	0	0
Launching Ramp	1	1	1	1	1
Paint/Sandblast Facility	Yes	Yes	Contracted	Yes	No
Major Maint. Capability	Yes	Yes	Yes	Yes	No
Storage (# Sections)					
Outdoor	21	>100	~150	Limited	> 200
Floating	28	8	20	15	No

* One is the container crane used to load and off-load the Maritime Prepositioning Ships at BIC.

PHIBCBONE

All the NL-related facilities at this base were sighted. The items of concern are whether the size and weight of the ACBL will pose an operational problem at the PHIBCBONE facilities.

Most of the cranes will be suitable for lifting the ACBL. There is a 150-ton Stratolift crane, two 75-ton hydraulic cranes, and two 140-ton lattice-boom cranes. These cranes can all handle the 30-ton weight and 24-foot x 40-foot dimensions projected for the ACBL sections. There are also two other hydraulic cranes that rated at 30 tons and could be used if the ACBL sections weigh-in at 30 tons.

The area available for storage of lighterage is at a premium. There is enough land area for seven of the current NLs to be stored. At this location, the NLs can be stacked three high. Therefore, 21 NLs can be stored in this area. There is also a floating storage area available at the end of a pier which can accommodate two columns of 14 NLs. These storage areas are currently full-to-capacity with NLs.

There is one building used for sandbasting and painting. The building has two bays. One bay is used by the Seebees for sandbasting and painting and the other is leased to a contractor. The Seabee bay is wide enough to accommodate the ACBL.

All the maintenance is performed in an outdoor laydown area in front of the paint/sandblast building and alongside the pier. The maintenance capacity is sufficient to fully disassemble, repair, and assemble the NLs. The ACBL can be accommodated by the existing program.

The final items sighted for consideration were the launching facilities. There is a ramp that can accommodate the ACBL. The other facility is a finger pier which is used by the Stratolift crane. This pier is not wide enough to use for the ACBL. It is only 22.5 feet wide with pile fenders installed. This pier would have to be modified or replaced.

PHIBCBONE provided labor hour estimates for some typical operations. Complete cost estimates could not be provided. According to personnel there, it requires approximately 720 hours to sandblast and paint one section.

PHIBCBTWO

PHIBCBTWO has two groups responsible for NL maintenance. One is responsible for maintaining the NL sections and the other is responsible for the SLWTs. A tour of each group’s facilities was provided.

Extensive information was provided by the SLWT maintenance group. Their maintenance document listing the required frequency, labor hours required to complete the maintenance item, and other information was also provided. The mechanics stated that an average of one hour can be added to the required hours listed on the maintenance document for preparation purposes. The

SLWT group can perform all the required maintenance on-site. Specific information and concerns are listed below.

- There are 9 SLWTs. These are stored on the water in front of the maintenance facility.

- There are two 150-ton Stratolift cranes shared by the SLWT and NL groups.

- There is a finger pier and a launch ramp available. The finger pier, however, is only 24 feet wide and probably too tight a fit for the 24-foot width of the ACBL. Only the shore-side end of the pier was measured. A suitable tape measure was not available for the outer end and that could be a different width.

- 400 to 500 hours per month per SLWT is the estimated time expended on maintenance.

- Standardization of parts and fluids would greatly decrease procurement delays currently experienced. It is a common occurrence to receive a part only to find out that an incompatible substitute was provided. According to mechanics, the reason for this is that the part called out in the design is not a standard item. Other systems using different fluids could also benefit from standardization.

- The oil pan plug is only 2 inches from the bottom of the hull. This requires that the oil be pumped out through the fill opening because a pan cannot be placed under the plug opening.

- The electric starter pumps should be used as primary and the hand pumps as secondary. If the weather is cold, it is very difficult and time-consuming to transfer the fluid.

- The electrical system is a ‘nightmare.’ One mechanic stated that the gages ‘can’t take abuse.’ He did not elaborate on what kind of abuse was supplied, but the general consensus was that the electrical system components are too sensitive to shock. The components are also hard to come by. Again, standardization may be a solution.

- The steering and starting systems require the majority of the maintenance hours used on the SLWTs. These two systems should be looked at in detail to reduce this time required.

Petty Officer Gaspar explained the NL maintenance program. Below are the findings discovered on the tour he conducted:

- The NL group has the capability to completely disassemble, repair, and assemble the NLs on-site.

- There are 42 NL sections as the base. There is more than adequate area for storage.

- There is a nine-month-old paint/sandblast facility with two bays. The sandblast system uses steel shot operating under a pressure of 80 psi and can operate up to 120 psi. The facility is permitted for IC531 inorganic zinc paint only. Permitting for other coatings is a difficult task.

Each bay is capable of performing both painting and sandblasting. The useable area in each bay is 150 feet long by 21 feet wide. The 21 feet is due to the 150-ton Marine Travellift crane that is mounted on rails inside the facility. The NLs are moved to a laydown area in front of the door of the facility and the Travellift crane travels out onto this area, lifts the NL section, and moves it inside. The inside dimension of the Travellift is 23 feet. The crane operator stated that there must be some clearance between the load and the crane, therefore, the 23 feet is reduced to 21 feet. Modification of this facility would be a major task because it would not be limited to only increasing this dimension by modifying the existing crane or using another. There are only inches of clearance between the outside of the crane and the door frame through which it travels.

- Each NL section requires 600 labor hours to sandblast and paint. This is performed every 2 years. The materials used are 10 gallons of primer, 40 gallons of zinc silicate, and 50 gallons of non-skid compound for the top deck.

Blount Island Command

Gerald Voynik arranged a tour of the NL assets at BIC and at the NL shipyard at Blount Island (BI). The NLs are off-loaded from Maritime Prepositioning Force (MPF) ships at BIC, towed about eight miles on a river down to the shipyard, overhauled at the shipyard, and then returned via the river to BIC for backloading onto the MPF ships. All the NL-related facilities were sighted. The items of concern are whether the size and weight of the ACBL will pose an operational problem at BI. The facilities sighted that could possibly be affected were: cranes, piers, storage area, paint/sandblast facility, and maintenance facility.

The shipyard uses a portal lattice boom crane for movement of the NLs. Its capacity is sufficient to lift ACBL. BIC uses a 150-ton Stratolift crane or the container crane used for the MPF ships. These cranes will accommodate the width and weight of the ACBL.

There are no piers at the shipyard. The NLs are placed into and removed from the river by the portal crane. The Stratolift crane is used on a launch ramp for the NLs at BIC. There will be no impact on this aspect of the operations.

There is limited storage area at the shipyard. A significant portion of this area is used for spare parts. BIC will soon deplete the Naval Supply System of all pontoons for the NLs. These will be stored at the shipyard or BIC until needed. BIC has ample area for storage. There are approximately 10 NLs dispositioned for the Defense Reutilization and Marketing Organization stored there. There are plans on the drawing board for converting an undeveloped area for storing 200 NL sections stacked one-high. This obviously could be used to store up to 600 sections if it is possible to stack them three-high.

The shipyard performs all of the sandblasting, painting, and maintenance of the NLs. The facilities utilized for these functions can all accommodate the ACBL.

During the tour of these facilities, Mr. Voynik identified some significant items regarding the maintenance of the NLs. Mr. Voynik stated that the number-one cost-saving feature that could be considered in the next generation of lighters is incorporation of a continuous-surface, monocoque design. If such a design feature can be incorporated into the next generation, Mr. Voynik estimates the maintenance cost could be cut by one-third. There are several items requiring inherently labor-intensive and high-cost maintenance during every two-year maintenance cycle. These items are all due to inaccessible features requiring maintenance. Inaccessible areas always require disassembly. The areas between the pontoons cannot be reached for sandblasting. The interfaces between the pontoons and structural members are corrosion problem-areas. These areas must be made accessible for maintenance. Compounding the disassembly requirement is the fact that several joints on the pontoons are now welded instead of bolted. It is clear that these problem areas would also be present if any modular type lighter were considered in the next generation. Assuming an average cost of approximately $35,000 per NL section for maintenance, the estimated savings for maintaining a monocoque design would be $11,700 per section.

Fort Eustis

Through an arrangement with CPT Gomol at 7th Group, SGT Lyons provided a tour of the Army's causeway assets at Ft. Eustis. The causeways are used by the Army as lighters. All the facilities present at the harbor were sighted. The facilities sighted that could possibly be affected were: cranes, piers, storage areas, and maintenance facilities. The Army compartmentalizes their Causeway program. One group does minor maintenance and operations and another does major maintenance. SGT Lyons is with the group that handles the minor maintenance and operations.

The Army causeway section is made up from 3 strings. Each string consists of two end pieces that are 8 feet wide and 20 feet long, weighing 11,650 pounds, and one center piece that is 8 feet wide and 40 feet long, weighing 22,500 pounds. There are 34 strings and 4 Side-Loadable Warping Tugs (SLWT), 2 of which were in working order.

The harbor area where causeway operations are performed has a 100-ton barge crane that lifts one string at a time. There is also a 125-ton Strato-Lift crane at Ft. Story that is available to the harbor. Rough Terrain Container Handlers (RTCH) are used to move the strings on land.

There are no finger piers at the harbor. There is a launching ramp and a dockside pier. The SLWTs are moored at the dockside pier.

Storage space is limited at the harbor. There is a maintenance yard approximately 1/2 mile away from the harbor with an area of 2,500 yds^2 that can be used for storage.

Minor maintenance that is required is done preferably at the harbor. The Army shares this facility with the public and cannot afford to tie up any area for a long period of time. All long-period maintenance items must be accomplished at the maintenance yard. Most of the maintenance that is performed at the harbor is completed within a 24-hour period. The factor contributing most significantly to the corrosion maintenance problem experienced by the Army is the fact that the Causeway sections are almost constantly in the water. There is not enough time between operations to remove the sections and place them into proper storage. Senior Marine Maintenance NCO Hatfield at the 331st Causeway Company under the 6th Battalion provided a copy of the Preventive Maintenance Checks and Services Chart used for the SLWTs. NCO Hatfield did not provide any information on the cost of these preventive maintenance items. He did, however, provide contacts at 7th Group (SFC Aguilar) and Army Troop Command (ATCOM) (Dan Browning) who may provide this information. Both of these contacts deal with the funding of maintenance items.

Points of Contact

PHIBCBONE

LT Newton
Phone: DSN 577-2528 (Comm. (619) 437-)
Comment: He is in charge of operations.

BM1 Freese
Phone: DSN 577-2536 (Comm. (619) 437-)
Comment: He provided the tour of the facility.

PHIBCBTWO

LCDR Crumb
Phone: DSN 680-7682
Comment: He was the initial point of contact for the visit and provided referral to MC Lockhart.

MC Lockhart.
Phone: DSN 680-7682
Comment: He conducted the tour of the facilities.

BIC

Mr. Gerald Voynik
Phone: (904) 696-5228
Comment: He was the initial point of contact and is in charge of the NL assets. He provided the tour of the shipyard and BI.

Mr. Terry Brewer
Phone: (904) 696-5373
Comment: He participated in the tour of the shipyard. He oversees the contractor operations at the shipyard.

Ft. Eustis

CPT Gomol
Phone: DSN 927-5507 (Comm: (804) 878-)
Comment: She is in charge of the Army's causeway assets at Ft. Eustis.

SGT Lyons
Phone: DSN 927-2404 (Comm: (804) 878-)
Comment: He conducted the tour of the facilities.